NATIONAL BUREAU OF STANDARDS REPORT

9998

CONCRETE BEAM AND COLUMN COMPUTER PROGRAMS

Modified for IBM 1130

For
The Construction Research Division
Post Office Department

NBS

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.

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Modified for IBM 1130

by
E. F. Carpenter
Structures Section
Building Research Division

for
The Construction Research Division
Post Office Department

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U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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1. INTRODUCTION

1.1 General

This is the first of a series of reports designed to modify, consolidate and co-ordinate certain existing structural computer programs to make them compatible with current building codes and the IBM 1130/Fortran IV language. This report is intended as a reference manual for the structural engineering use of eight concrete beam and column computer programs.

The following programs are included:

(1) Reinforced concrete beam with a small axial load. (Selects reinforcing steel for given outside dimensions.

(2) Composite steel and concrete beam design.

(3) Analysis of reinforced concrete beam with tensile reinforcement only.

(4) Analysis of short, rectangular concrete columns subject to biaxial bending.

(5) Analysis of short, irregular concrete column subject to biaxial bending.

(6) Rectangular tied column subject to planar bending (Load-Moment envelope for short columns).

The original computer programs were written in various fortran forms including RCA 301/Fortran, IBM 1620/Fortran, IBM 7044/Fortran IV, and IBM 360/Fortran IV. These have all been modified to IBM 1130/Fortran operable with the following equipment:

(a) IBM 1130, Model 2C, 16K storage/Version II

(b) IBM 1132 Printer

(c) IBM Card Read-Punch

(d) IBM 2315 Disc Cartridge, removable/interchangeable.

1.2 Scope

Each program has been checked for Building Code references, and modified or changed where necessary to meet ACI 318-63 and AISC-63 specifications.

Programs have been debugged by performing an illustrative problem. No comprehensive full scale attempt has been made to check against manual solutions and establish analytical validity. The user must satisfy himself as to reliability by testing the program with problems of known solution. Good Engineering practice dictates that each program be used initially as a checking analysis until the User gains sufficient confidence and insight into the program's behavior. The theoretical basis and program abstracts described in Section 2 thru Section 7 are presented to provide the User a quick reference as to the general nature of the program. Several of these programs, notably 1.A.1, 1.B.1 and 1.B.2 have been previously documented in considerable detail. If further information is required, reference can be made to those documents.

A standard description sheet of each program is included in the summary to provide a consolidated definition of the program.

1.3 Program and Sample Problem Listing

Program listings include a sample problem output to illustrate the type of solution provided by the computer. These problems have been used for debugging purposes, but are not designed to test the reliability of the program.

The listings were taken directly from the source decks, and include all the normal job control cards for the IBM 1130 equipment.

2. PROGRAM 1.A.1 - CONCRETE BEAM, AXIALLY LOADED

2.1 Purpose

The purpose of Program 1.A.1 is to select reinforcing steel for an axially loaded concrete beam of given dimensions.

2.2 Theoretical Basis

Analytical calculations are based on conventional "straight line" theory for balanced design. Allowable material stresses are specified in accordance with ACI 318-6 recommendation for "working stress design" for beams. This dictates a loading situation free from instability considerations, i.e., a tension axial load or a small compressive axial load.

2.3 Method of Execution

Program input includes the allowable steel stress, cylinder strength of concrete, beam dimensions, and applied forces at the cross-section of interest.

The program computes an initial value of steel area assuming balanced design. This value is used to calculate the necessary depth of the concrete compression zone. An iterative process repeats the cycle until the computed depth and used depth of compression are approximately the same.

2.4 Input

Input parameters are read by the computer in the following sequence:

Card 1. JOB - Job Title

Card 2. FC - Cylinder strength of concrete, fc^1 (lbs./sq. in)
FS - Allowable steel stress, fs (lbs./sq. in.)
WC - Density of concrete (lbs./cu. ft.)

Card 3. V - Total shear (kips)
M - Moment at the section (kip-ft.)
FN - Axial force, + for compression (kips)
DT - Overall depth of beam (ins.)
B - Width of Compressive area of beam (ins.)

D - Depth of tensile steel, d(ins.)

DP - Depth of compressive steel, d' (ins.).

Form S-1A1 illustrates sample input data. This input information is also included in the program output listing L-1A1.

2.5 Output

An illustration of sample output is included; with notes, after the program listing. Output information includes the following:

Job title
Input parameters
Depth of compression zone
Allowable shear and actual shear
Allowable concrete stress and actual stress
Tensile steel area and stress
Compressive steel area and stress.

3. PROGRAM 1.A.2 - COMPOSITE BEAM SECTION PROPERTIES

3.1 Purpose

The purpose of Program 1.A.2 is to compute the bottom flange area and the cross-sectional characteristics of a concrete slab and steel beam composite section.

3.2 Theoretical Basis

All calculations assume elastic materials with no tensile strain in the concrete slab. Composite section inertia computations are based on strain continuity between steel and concrete. Non-composite section calculations consider only the steel beam, and are to be used for construction loads.

3.3 Method of Execution

The program will consider only one beam at a time; however, the slab plus the web and lower flange of the steel beam can be varied in depth and width to optimize efficiency of material geometry.

Using the input geometry and modular ratio of materials, the computer generates the non-composite and composite section modulus by the conventional method of first locating the neutral axis and then calculating the moment of inertia.

3.4 Input

Input parameters are read by the computer in the following sequence:

Card 1. A - Job Title

Card 2. XN - Modular Ratio, n (ACI 318-63)
NOFWZ - Number of web sizes
ID - 0 or 1*

Card 3. W3 - Width of top flange of steel (ins.)
D3 - Depth of top flange of steel (ins.)

Card 4. D4 - Initial depth of concrete (ins.)
NID4 - Number of D4 being generated
SID4 - Size of increment added to D4 (ins.)

T4 - Width-depth ratio of concrete**

Card 5. D1 - Initial depth of bottom flange (ins.)
NID1 - Number of D1's being generated
SID1 - Size of increment for D1 (ins.)

Card 6. T1 - Initial width-depth ratio of bottom flange
(ID=0) NIT1 - Number of T1's required
SIT1 - Increment size for T1 (ins.)

Card 6. W1 - Initial width of bottom flange (ins.)
(ID=1) NIW1 - Number of W1's required
SIW1 - Increment size for W1 (ins.)

Card 7, W2 - Web thickness (ins)
etc. D2 - Web depth (ins.)

*ID is a control number for bottom flange input where "0" decides that Width-depth ratio is to be varied, and "1" decides that the width will be varied, but not the thickness.

**The width of concrete is obtained by multiplying D4xT4. If T4 is left blank, the program supplys W4=16D4+W3 as required by AISC specifications.

4. PROGRAM 1.A.3 - CONCRETE BEAM REVIEW

4.1 Purpose

Program 1.A.3 will analyze a reinforced concrete beam with tension steel only. It is more efficient than manual analysis only if there is a number of known cross-sections to be considered.

4.2 Theoretical Basis

Computations are based on simple "working stress design" as described in the ACI Building Code.

4.3 Method of Execution

The computer first reads material characteristics. It next accepts any number of cross-section dimensions. The "WSD" equations are then solved for resisting moments of concrete and steel.

4.4 Input

Input parameters are read into the computer in the following sequence:

Card 1. FS - allowable steel stress (psi)
FC - allowable concrete stress (psi)
AN - modular ratio, n

Card 2. AS - area of tension steel (sq. in.)
etc. B - width of beam (ins.)
D - depth to steel (ins.)

4.5 Output

Output symbols are defined as follows:

P - ratio of steel to concrete (As/bd)
K - dimensionless depth of compressive Zone (k)
J - dimensionless internal moment arm (j)
MS - resisting moment of steel (kip-ft)
MC - resisting moment of concrete (kip-ft).

5. PROGRAM 1.B.1 - BIAXIAL BENDING OF RECTANGULAR COLUMNS

5.1 Purpose

Program 1.B.1 analyzes any short rectangular concrete column subjected to biaxial bending and determines the cross-sectional stress pattern.

5.2 Theoretical Basis

The method of solution is based on Paper No. 3239, Analytical Approach to Biaxial Eccentricity by E. Czerniak, ASCE Proceedings, Volume 88, No. ST4, August, 1962, Part I.

Theory is limited to the two basic assumptions: (A) plane sections remain plane; and (b) equilibrium conditions are satisfied.

Although the original reference reportedly is generalized for non-linear materials, the program considers the special case where elasticity prevails.

5.3 Method of Execution

Given the applied forces (relative to center lines) and the cross-section characteristics, the computer employs an iterative procedure to locate the neutral axis of the transformed section. Compressive reinforcement is transformed by the factor (2n-1) to allow for creep.

The program then computes the maximum concrete stress and the steel stress for each bar.

5.4 Input

Input parameters are arranged in the following sequence:

Card 1. Title, Users initials and date

Card 2.
T - thickness of member along Y-axis (ins.)
D - depth of member along X-axis (ins.)
*XMX - moment about X-axis centerline (kip-ft)
XMY - moment about Y-axis centerline (kip-ft)
THR - compressive Load (kips)
EN - modular ratio of steel to concrete

*The X-Y co-ordinates are chosen so that the column edges with maximum compression lie on the axes.

Card 3. BARNO - identification number of re-bars. Last number must be 100.
ACORX - the "X" distance to a re-bar. (ins)
ACORY - the "Y" distance to a re-bar. (ins)
AREA - area of the Re-bar (sq. ins)

Card 4. XLOAD - If "O" read card #1; if "1" read Card #5

Card 5. XMX (Card #5 is included if a second
XMY force system is to be applied to the
THR given cross-section.)

5.5 Output

Output of the input data is in the same sequence as read, and is identified by complete sentences. Output of calculated data is self-explanatory, and includes the following information:

(a) Equivalent eccentricities of axial load.
(b) Properties of Section and stresses for the given section.
(c) Properties of Section and Stresses for the given section, but neglecting compressive steel in neutral axis solution.

6. PROGRAM 1.B.2 - BIAXIAL BENDING OF NONPRISMATIC COLUMNS

6.1 Purpose

Program 1.B.2 will analyze any shape concrete section (including rectangular) subjected to an axial load and biaxial bending. It considers cross-sectional stress pattern, but not column stability.

8.2 Theoretical Basis

The following general flexure formula is used to solve for concrete stresses:

$$f = \frac{P}{A} + \left[\frac{Mx_o - My_o \dfrac{Ix_oy_o}{Iy_o}}{Ix_o - \dfrac{(Ix_oy_o)^2}{Iy_o}} \right] x_o + \left[\frac{My_o - Mx_o \dfrac{Ix_oy_o}{Ix_o}}{Iy_o - \dfrac{(Ix_oy_o)^2}{Ix_o}} \right] y_o$$

or:

$$f = a + bx + cy$$

The above equation defines the neutral axis location when

f=0. Theory is based on linear analysis and does not consider second order buckling. Thus the maximum length of column will be in accordance with code restrictions as set in ACI 318-63, Sections 915 and 916.

6.3 Method of Execution

The program determines the neutral axes location of the transformed section using an iterative procedure to solve the general flexure equation for the case when f=0. The computer then determines material stresses throughout the section. The geometry of the section is defined in cartesian co-ordinates.

6.4 Input

All input must be consistent in units. i.e., if the geometry is measured in inches, then the moments must be kip-ins. All output will be in the same system of units as input.

Card 1. Title

Card 2. NCON - The number of intersections (plus

one) of concrete boundry lines.

NSTL - Number of rows of steel

NLD - Number of sets of loads to be considered

ISWTI - A control option. Read "1" in if it is desirable to provide the computer with an estimate of the neutral axis location.

Card 3* XCON - X co-ordinates of concrete shape listed clockwise. (counter clockwise for the hole in a hollow shaft). The origin can be at any convenient location.

YCON - "Y" coordinates corresponding to "X" coordinates (not to exceed 100 points)

Card 4** AS - Area of one steel bar

XISTL - "X" coordinate of one bar or the first bar in a row.

YISTL - "Y" coordinate corresponding to the "X" coordinate

BARNO - Number of bars being described

X2STL - "X" Coordinate of last bar in the row

Y2STL - "Y" Coordinate of last bar in the row

*Card 3 represents a type for which there will normally be more than one, since only three points can be located by one cord.

**Card 4 represents a type for which there will be "NSTL" cards.

Card 5* CODE - Name of Load (i.e., L.L.+D.L.)

P - Axial Load acting at the origin (+=compression)

XM - Moment about the Y axis with P at the origin (+=clockwise)

YM - Moment about the Y axis with P at the origin (+=clockwise)

RATIO - Modular Ratio, n of steel to concrete.

B - Ratio of the effective modulus of the reinforcement in compression to that in tension (normally 2.0 for creep allowance. Note that B=0.0 stimulates holes in the compressive concrete.)

ACCR - Accuracy Desired. Maximum allowable Concrete Stress change between final iterations (e.g., .010 k.s.i.)

*Card 5 represents a type for which there will be "NLD" cards.

Card 6* IDENT - Any interger used to identify the "first guess card."

S - Estimate of the neutral axis x-coefficient

T - Estimate of the neutral axis y-coefficient

U - The constant term

*Card 6 is an optional card not normally used. It is only to be included if ISW1 has been read as "1".

This program has a "stacked job capability." After all load cases have been computed for the first cross-section, the computer returns and looks for a new job Title (Card 1). If the user prefers to retain the concrete shape and vary the steel arrangement, he can do so by placing a zero in column 10 of Card 2 of the second set of cards. This signals the computer to next read the steel Card 4 and use the concrete shape defined on the original Card 3.

68.5 Output

Output data is in the same units as the input and includes the following:

P - Given axial load
MX - Given moment about Y-axis (XM)
MY - Given moment about X-axis (YM)
N - Modular ratio given (RATIO)
R - Ratio of effective compressive steel (B)

ITERATION COUNT - Number of trials to locate neutral axes.

GENERAL FORMULA - Gives numerical values of the flexure formula coefficients.

The computer than lists material stresses and locations. Negative stresses indicate tensile zones.

7. PROGRAM 1.B.3 - TIED CONCRETE COLUMNS, PLANAR BENDING

7.1 Purpose

Program 1.B.3 analyzes a concrete column of known cross-section and develops the allowable load-moment envelope (interaction) curve for working stress design as defined by the ACI 318-63 building code.

7.2 Theoretical Basis

Computations are based on ACI equations for working stress design contained in Chapter 14 of ACI318-63. No provision is made for long slender columns as defined by Section 915 of the ACI code. Referring to ACI notation, the following equations are solved:

7.9 Input

Input parameters are read in the following sequence.

Card 1 FY - Yield stress of re-bar, fy (p.s.i.)
FCP - Concrete compression Strenght, fc' (p.s.i.)

C - Concrete working stress factor (0.45)

EN - Modular Ratio of Steel to Concrete, n

B - Breadth of Beam (ins.)

T - Total Depth of Beam (ins.)

D - Depth to Steel (ins.)

G - Ratio of distance between compression-tension rebar to total depth of beam.

Card 2* AS - Area of tensile re-bar (sq.in.)

ASP - Area of compressive re-bar (sq.in.)

Card 2 represents a type. There is no limit to the number of of steel area cards for any given column.

7.4 Output

Output includes values for Po/AgFc', Nb/Agfc', Mb/Agf'ct, Mo/Agf'ct, Po, Pa, Nb, Mb, and Mo. This data can be used to plot the type of load envelope shown on the output listing.

SUMMARY SHEET FOR PROGRAM NO. 1A1

PROGRAM NAME: Concrete Beam Axially Loaded

A. TYPE OF MATERIAL

☒ 1. Concrete
☐ 2. Steel

B. TYPE OF STRUCTURE

☒ 1. Beams and Girders
☐ 2. Columns
☐ 3. Composite Beams
☐ 4. Foundations
☐ 5. Frames and Tunnels
☐ 6. Prestress Construction
☐ 7. Shells
☐ 8. Slabs

C. REFERENCE CODES

☒ 1. A.C.I.
☐ 2. A.I.S.C.
☐ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

☒ 1. Elastic Analysis
☐ 2. Plastic Analysis
☐ 3. Working Strength Design
☐ 4. Ultimate Strength Design

E. REMARKS

Chooses re-bar for axially-loaded concrete beam.

SUMMARY SHEET FOR PROGRAM NO. 1A2

PROGRAM NAME: Composite Beam Section Properties

A. TYPE OF MATERIAL

x 1. Concrete
x 2. Steel

B. TYPE OF STRUCTURE

____ 1. Beams and Girders
____ 2. Columns
x 3. Composite Beams
____ 4. Foundations
____ 5. Frames and Tunnels
____ 6. Prestress Construction
____ 7. Shells
____ 8. Slabs

C. REFERENCE CODES

x 1. A.C.I.
x 2. A.I.S.C.
____ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x 1. Elastic Analysis
____ 2. Plastic Analysis
____ 3. Working Strength Design
____ 4. Ultimate Strength Design

E. REMARKS

Checks cross-sectional characteristics and optimizes selection of steel beam.

SUMMARY SHEET FOR PROGRAM NO. 1A3

PROGRAM NAME: Concrete Beam Review

A. TYPE OF MATERIAL

☒ 1. Concrete
☐ 2. Steel

B. TYPE OF STRUCTURE

☒ 1. Beams and Girders
☐ 2. Columns
☐ 3. Composite Beams
☐ 4. Foundations
☐ 5. Frames and Tunnels
☐ 6. Prestress Construction
☐ 7. Shells
☐ 8. Slabs

C. REFERENCE CODES

☒ 1. A.C.I.
☐ 2. A.I.S.C.
☐ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

☐ 1. Elastic Analysis
☐ 2. Plastic Analysis
☒ 3. Working Strength Design
☐ 4. Ultimate Strength Design

E. REMARKS

Analyzes simple concrete beam - a trivial problem unless a large number of beams involved.

SUMMARY SHEET FOR PROGRAM NO. 1B1

PROGRAM NAME: Biaxial Bending of Rectangular Columns

A. TYPE OF MATERIAL

☒ 1. Concrete
☐ 2. Steel

B. TYPE OF STRUCTURE

☐ 1. Beams and Girders
☒ 2. Columns
☐ 3. Composite Beams
☐ 4. Foundations
☐ 5. Frames and Tunnels
☐ 6. Prestress Construction
☐ 7. Shells
☐ 8. Slabs

C. REFERENCE CODES

☒ 1. A.C.I.
☐ 2. A.I.S.C.
☐ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

☒ 1. Elastic Analysis
☐ 2. Plastic Analysis
☐ 3. Working Strength Design
☐ 4. Ultimate Strength Design

E. REMARKS

Computes Cross-Sectional capacity, i.e., the "Biaxial Interaction Envelope" of a short column can be easily generated.

SUMMARY SHEET FOR PROGRAM NO. 1B2

PROGRAM NAME: Biaxial Bending of Irregular Columns

A. TYPE OF MATERIAL

x 1. Concrete
___ 2. Steel

B. TYPE OF STRUCTURE

___ 1. Beams and Girders
x 2. Columns
___ 3. Composite Beams
___ 4. Foundations
___ 5. Frames and Tunnels
___ 6. Prestress Construction
___ 7. Shells
___ 8. Slabs

C. REFERENCE CODES

x 1. A.C.I.
___ 2. A.I.S.C.
___ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x 1. Elastic Analysis
___ 2. Plastic Analysis
___ 3. Working Strength Design
___ 4. Ultimate Strength Design

E. REMARKS

Similar to Program 1.B.1, but can also handle irregular shapes.

SUMMARY SHEET FOR PROGRAM NO. 1B3

PROGRAM NAME: Tied Concrete Columns, Planar Bending

A. TYPE OF MATERIAL

_x_ 1. Concrete
___ 2. Steel

B. TYPE OF STRUCTURE

___ 1. Beams and Girders
_x_ 2. Columns
___ 3. Composite Beams
___ 4. Foundations
___ 5. Frames and Tunnels
___ 6. Prestress Construction
___ 7. Shells
___ 8. Slabs

C. REFERENCE CODES

_x_ 1. A.C.I.
___ 2. A.I.S.C.
___ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

___ 1. Elastic Analysis
___ 2. Plastic Analysis
_x_ 3. Working Strength Design
___ 4. Ultimate Strength Design

E. REMARKS

Develops the allowable "Interaction Envelope".

SAMPLE INPUT FORMS

IBM

FORTRAN Coding Form

PROGRAM 1A1 - Concrete Beam - Axial Load

PROGRAMMER Earle F. Carpenter

DATE February 1, 1969

PUNCHING INSTRUCTIONS GRAPHIC PUNCH

PAGE 1 OF 1

CARD ELECTRO NUMBER*

COMM. / STATEMENT NUMBER (1-5)	CONT. (6)	FORTRAN STATEMENT (7-72)	IDENTIFICATION SEQUENCE (73-80)

```
  SAMPLE PRØBLEM FØR 1A1                                                CARD # 1
3000.     20000.    145.                                                CARD # 2
10.       100.      10.       24.       12.       22.       2.          CARD # 3
```

EXPLANATION

```
  Problem "TITLE" - Up to one card in length                            CARD # 1
|←   f'_c (psi)  →|←   fs (psi)    →|←   Wc (#/c.f.)  →|                CARD # 2
|← SHEAR (kips) →|← MOMENT (k-ft) →|← AXIAL LOAD (kips) →|← t (inches) →|← b (inches) →|← d (inches) →|← d' (inches) →|   CARD # 3
```

*A standard card form, IBM electro 888157, is available for punching statements from this form

Input Form No. 5.1

IBM

FORTRAN Coding Form

PROGRAM 1A2 - Composite Beam Section Properties

PROGRAMMER Earle F. Carpenter

DATE February 3, 1969

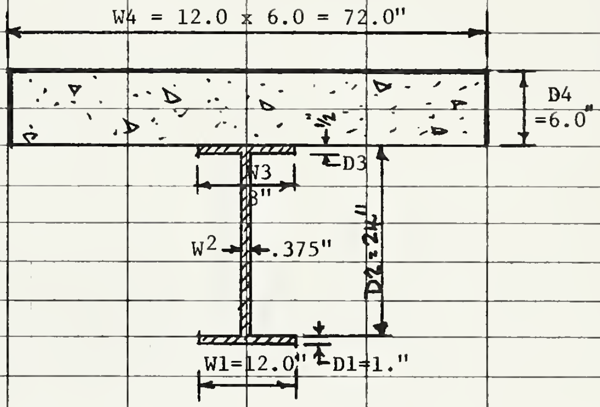
PUNCHING INSTRUCTIONS GRAPHIC PUNCH

PAGE 1 OF 1

CARD ELECTRO NUMBER*

STATEMENT NUMBER | CONT. | FORTRAN STATEMENT | IDENTIFICATION SEQUENCE

```
          SAMPLE  PRØBLEM FØR 1A2                                       CARD # 1
10.      1    1                                                         CARD # 2
8.        .5                                                            CARD # 3
6.                 1      0.  12.                                       CARD # 4
1.                 1         0                                          CARD # 5
12.                1         0                                          CARD # 6
.375      24.                                                           CARD # 7
```



EXPLANATION

```
          PROBLEM TITLE (UP TO ONE FULL CARD)                           CARD # 1
N(Es/Ec) NOFWZ   ID ▨                                                   CARD # 2
←— W3 (inches) →←— D3 (inches) —→                                       CARD # 3
←D4 (inches) ——→←———— NID4 ——→← SID4 (inches) —→←— T4 —————→            CARD # 4
←D1 (inches) ——→←———— NID1 ——→          SID1 —▨                          CARD # 5
←W1 (inches) ——→←———— NIW1 ——→          SIW1 —▨                          CARD # 6
←W2 (inches) ——→←D2(inches) ——→                                         CARD # 7
```

*A standard card form, IBM electro 888157, is available for punching statements from this form

Input Form No. 5.2

IBM

FORTRAN Coding Form

PROGRAM 1A3 - Concrete Beam Review
PROGRAMMER Earle F. Carpenter
DATE February 3, 1969
PUNCHING INSTRUCTIONS GRAPHIC PUNCH
PAGE 1 OF 1
CARD ELECTRO NUMBER*

STATEMENT NUMBER (1-5) / CONT. (6) / 7-10	11-20	21-30	IDENTIFICATION SEQUENCE (73-80)
20000.	1350.	10.	CARD # 1
6.93	17.0	31.0	CARD # 2
		EXPLANATION	
← fs (psi) →	← fc (psi) →	← N = Es/Ec →	CARD # 1
As (sq. in.)	← b (ins.) →	← d (ins) →	CARD # 2

*A standard card form, IBM electro 888157, is available for punching statements from this form

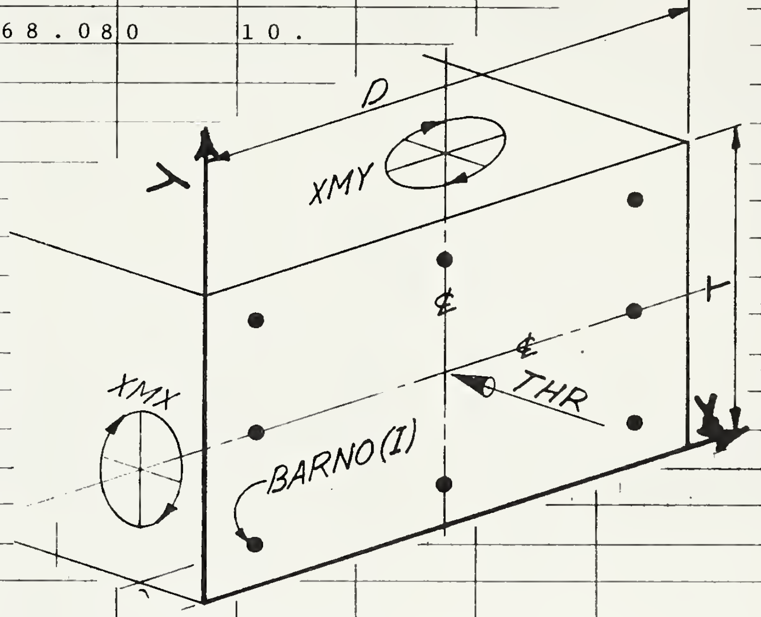
Input Form No. 5.3

IBM

FORTRAN Coding Form

PROGRAM 1B1 - BIAXIAL BENDING OF RECTANGULAR COLUMN		PUNCHING INSTRUCTIONS	GRAPHIC / PUNCH	PAGE 1 OF 1
PROGRAMMER Earle F. Carpenter	DATE February 3, 1969			CARD ELECTRO NUMBER

```
TEST CASE NØ 1 FØR SP-17   FØR 1B1                                      CARD # 1
17.       25.       22.693    113.467   68.080    10.                   CARD # 2
1.        2.5       2.5       .79                                       CARD # 3 A
2.        12.5      2.5       .79                                              B
3.        22.5      2.5       .79                                              C
4.        2.5       8.5       .79                                              D
5.        22.5      8.5       .79                                              E
6.        2.5       14.5      .79                                              F
7.        12.5      14.5      .79                                              G
100.      22.5      14.5      .79                                              H
0.                                                                      CARD # 4
```



```
                    EXPLANATION

          PROBLEM TITLE(UP TO ONE FULL CARD)                            CARD # 1
<-T(ins)--><-D(ins)---> Mx(K-ins)My(K-ins)  THR(Kip)  N=Es/Ec           CARD # 2
BAR NO.   X(ins)     Y(ins)     As(sq.in)                               CARD # 3
XLOAD                                                                   CARD # 4
```

*A standard card form, IBM electro 888157, is available for punching statements from this form

Input Form No. 5.4

IBM

FORTRAN Coding Form

PROGRAM 1B2 - Biaxial Bending of Irregular Columns

PROGRAMMER Earle F. Carpenter

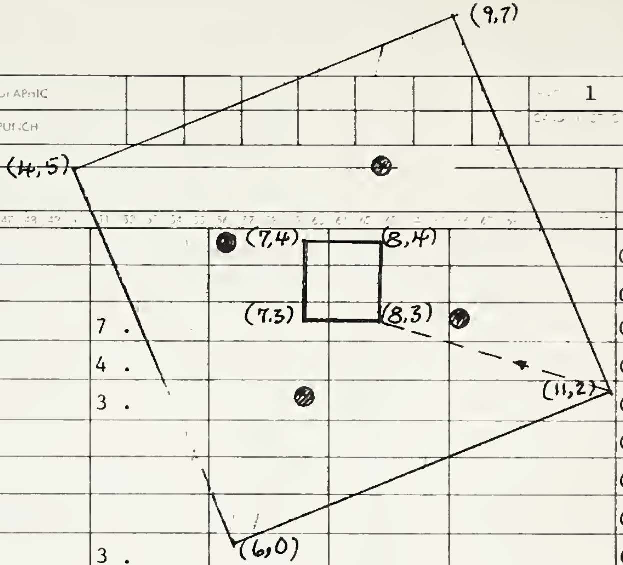
DATE February 3, 1969

PUNCHING INSTRUCTIONS GRAPHIC PUNCH

PAGE 1 OF 1

FORTRAN STATEMENT

```
    HØLLØW REINFØRCED SHAFT FØR 1B2                                     CARD #1
        11         3         2                                          CARD #2
6.        0.        4.        5.        9.        7.                    CARD #3A
11.       2.        8.        3.        8.        4.                    CARD #3B
7.        4.        7.        3.        8.        3.                    CARD #3C
11.       2.        6.        0.                                        CARD #3D
1.        7.        2.        1.                                        CARD #4A
1.        6.        4.        1.                                        CARD #4B
1.        8.        5.        2.        9.        3.                    CARD #4C
 LL+DL              10.       80.       50.       10.       2.        .01 CARD #5A
 LL + DL + WIND     10.       60.       10.       10.       2.        .01 CARD #5B
```



EXPLANATION

```
                    PROBLEM TITLE (UP TO ONE CARD IN LENGTH)            CARD #1
      NCON→▨    NSTL→▨    NLD→▨     ISWTI→▨   (optional)                     #2
XCON(ins) YCON(ins) XCON(ins) YCON(in)  XCON(ins) YCON(ins)                  #3
 AS(sq.in)XISTL(ins)YISTL(ins) BARNO    X2STL(ins)Y2STL(ins)                 #4
←CODE ──────────→   P(kips)   Mx(K-in)  My(K-ins)  n=Es/Ec ←B──────→ACCR     #5
```

*A standard card form, IBM electro 888157, is available for punching statements from this form

Input Form No. 5.5

IBM

FORTRAN Coding Form

X28-7327-6 U/M 025
Printed in U.S.A.

PROGRAM 1B3 - Tied Concrete Columns - Planar Bending		PUNCHING INSTRUCTIONS	GRAPHIC / PUNCH
PROGRAMMER Earle F. Carpenter	DATE February 3, 1969	PAGE 1 OF 1	CARD ELECTRO NUMBER

FORTRAN STATEMENT

```
40000. 3000.. .45   9.2  18.   28.   25.5.822                               CARD # 1
3.16 2.40                                                                   CARD # 2A
2.40 3.16                                                                         2B
4.00 3.16                                                                         2C
3.16 4.00                                                                         2D
5.08 4.00                                                                         2E
4.00 5.08                                                                         2F
5.08 3.16                                                                         2G
3.16 5.08                                                                         2H
```

EXPLANATION

```
fy (psi) | f'c (psi) | C | n = Es/Ec | b (ins) | t (ins) | d (ins) | G |       CARD # 1
 As | A's |                                                                  CARD # 2
```

Input Form No. 5.6

LISTING AND SAMPLE OUTPUT FOR 1.A.1

"Concrete Beam Axially Loaded"

```
// JOB 1
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C     W.S.D. OF CONCRETE BEAM WITH AXIAL LOAD
C     FC= 28 DAY CONCRETE STRENGTH (PSI)
C     FS= ALLOWABLE STEEL STRESS (PSI)
C     V= SHEAR FORCE  (KIPS)
C     FN= AXIAL FORCE(KIPS)
C     M= MOMENT(K-FT)
C     DT= BEAM DEPTH(IN)
C     B=  BEAM WIDTH(IN)
C     D= DEPTH TO STEEL (IN)
C     DP= DEPTH TO COMP. STEEL(IN)
      EXTERNAL ZZ,ZY
      REAL M
      DIMENSION JOB(16), Z(20)
      COMMON CFB,CFC,CFD,XL,XR,IER,CK,RFC,B,V,AMF
      DATA ES/29E6/
1     READ (2,41) JOB
      READ (2,42) FC,FS,WC
      READ (2,39) V,M,FN,DT,B,D,DP
      WRITE (3,47) JOB
      WRITE (3,48) FC,FS,V,FN,M,DT,B,D,DP
      AC=0.
      RFC=SQRT(FC)
      AVMAX=1.75*RFC
      EC=WC**1.5*33.*RFC
      DT=DT/12.
      B=B/12.
      D=D/12.
      DP=DP/12.
      AM=ABS(M)
      AMF=AM
      FSK=FS/1000.
      FCK=FC/1000.
      AFCA=.45*FC
      N=10.*ES/EC+.5
      AN=FLOAT(N)/10.
      AK=FLOAT(INT(1./(1.+FS/AN/AFCA)*1000.+.5))/1000.
      AJ=FLOAT(INT((1.-AK/3.)*1000.+.5))/1000.
      AJD=AJ*D
      Z(1)=AK*D
      UV=V/(B*D*.144)
      DO 32 J=1,19
      JP=J+1
      IF (FN) 10,2,10
2     CONTINUE
      AS=FLOAT(INT(AM/(FSK*AJD)*100.+.5))/100.
      CA=AN*AS/B/72.
      CB=(AN-1.)*AC/B/72.
      CFB=CA+CB
      CFC=-CA*D-CB*DP
      X=ROOT(CFB,CFC)
      Z(JP)=X
      AJD=D-X/3.
      AFC=1000.*AM/(72.*B*X*AJD+(AN-1.)/X*AC*(X-DP)*(D-DP))
      IF (AFC-AFCA) 4,4,3
3     AC=AC+FLOAT(INT(7200*(AFC-AFCA)*B*X/FS*X*AN/((AN-1.)*(X-DP))+.5))/
     1100.
4     CONTINUE
      IF (J-1) 6,5,6
```

```
5      IF (AC) 32,6,32
6      CONTINUE
       IF (ABS(X-Z(J))-.002*D) 7,7,32
7      CONTINUE
       AVBAS=AVB(AS)
       IF (AVBAS-AVMAX) 9,9,8
8      AVBAS=AVMAX
9      CONTINUE
       GO TO 34
10     PM=AM-FN*(4.*DT-D)/8.
       AMF=PM
       E=AM/FN+D-DT/2.
       DO 31 I=1,19
       IF (I-1) 11,11,22
11     CONTINUE
       IP=I+1
       IF (FN) 12,14,13
12     IF (E) 14,14,15
13     IF (E-AJD) 18,14,14
14     CONTINUE
       CK=125.*FN/FS*AN/B*E/D**2/3.
       XL=.1
       XR=15.
       CALL TPOLY (A,ZY,.005,20)
       IF (IER-1) 21,37,38
15     AFN=-FN
       AS2=E/(D-DP)*AFN/FSK
       AS1=AFN/FSK-AS2
       AVBAS=AVB(AS1)
       IF (AVBAS-AVMAX) 17,17,16
16     AVBAS=AVMAX
17     CONTINUE
       WRITE (3,44) AS1,AS2,AVBAS,UV
       GO TO 1
18     AG=B*DT
       AVC=AVMAX*SQRT(1.+FN/36./AG)
       FCA=(FN+6.*AM/DT)/(AG*.144)
       IF (FCA-AFCA) 20,20,19
19     WRITE (3,45)
20     WRITE (3,46) FCA,AVC,UV,AFCA
       GO TO 1
21     AFC=FS/AN/A                                                          1
22     IF (AFC-AFCA) 24,24,23                                               1
23     AC=AC+FLOAT(INT(7200*(AFC-AFCA)*B*Z(I)/FS*Z(I)*AN/((AN-1.)*(Z(I)-D   1
      1P))+.5))/100.                                                        1
24     CONTINUE                                                             1
       AS=(FN*(E-AJD)/FSK-AC*(AN-1.)/AN*(Z(I)-DP)*(Z(I)/3.-DP)/(D-Z(I)))/   1
      1AJD                                                                  1
       AS=FLOAT(INT(100.*AS+.5))/100.                                       1
       IF (AS-.01) 18,18,25                                                 1
25     CONTINUE                                                             1
       CFB=3.*(E-D)                                                         1
       CA=AN*AS*E/B/24.                                                     1
       CB=(AN-1.)*AC*(E-D+DP)/B/24.                                         1
       CFC=CA+CB                                                            1
       CFD=-CA*D-CB*DP                                                      1
       XL=.01*D                                                             1
       XR=.9*D                                                              1
       CALL TPOLY (X,ZZ,.005,20)                                            1
       Z(IP)=X                                                              1
       IF (IER-1) 26,37,38                                                  1
26     CD=72.*B*X                                                           1
```

```
      CE=(AN-1.)*(X-DP)/X                                                      1
      CF=-AN*(D-X)/X                                                           1
      AFC=FM*1000./(CD+CE*AC+CF*AS)                                            1
      IF (I-19) 27,33,27                                                       1
27    CONTINUE                                                                 1
      AJD=D-X/3.                                                               1
      IF (ABS(X-Z(I))-.002*D) 28,28,31                                         1
28    CONTINUE                                                                 1
      AVBAS=AVB(AS)                                                            1
      IF (AVBAS-AVMAX) 30,30,29                                                1
29    AVBAS=AVMAX                                                              1
30    CONTINUE                                                                 1
      GO TO 34                                                                 1
31    CONTINUE                                                                 1
32    CONTINUE                                                                 1
33    WRITE (3,39) Z(20)                                                       1
34    FSC=(AN-1.)*AFC*(X-DP)/X                                                 1
      IF (AC) 36,35,36                                                         1
35    FSC=0.                                                                   1
36    CONTINUE                                                                 1
      AFS=AN*AFC*(D-X)/X                                                       1
      X=12.*X                                                                  1
      WRITE (3,49) X,AVBAS,UV,AFCA,AFC,AS,AFS,AC,FSC                           1
      GO TO 1                                                                  1
37    WRITE (3,40)                                                             1
      GO TO 1                                                                  1
38    WRITE (3,43)                                                             1
      GO TO 1                                                                  1
C                                                                              1
C                                                                              1
39    FORMAT (8F10.0)                                                          1
40    FORMAT (31H0THERE IS NO ROOT IN THIS RANGE)                              1
41    FORMAT (16A5)                                                            1
42    FORMAT (8F10.0)                                                          1
43    FORMAT (41H0FUNCTION DOES NOT CONVERGE IN THIS RANGE)                    1
44    FORMAT (60H0BEAM IS ENTIRELY IN TENSION.  THE REINFORCEMENT REQUIR       1
     1ED ISF7.2,4H ANDF7.2,35H SQUARE INCHES.  ALLOWABLE SHEAR ISF6.0,11       1
     2H LBS/SQ IN./20H THE SHEAR STRESS ISF6.0,11H LBS/SQ IN.)                 1
45    FORMAT (74H0BEAM IS ENTIRELY IN COMPRESSION AND COMPRESSIVE REINFO       1
     1RCEMENT IS REQUIRED)                                                     1
46    FORMAT (63H0BEAM IS ENTIRELY IN COMPRESSION AND THE MAXIMUM COMPRE       1
     1SSION ISF7.0,31H LBS/SQ IN.  ALLOWABLE SHEAR ISF6.0,11H LBS/SQ IN.       1
     2/20H THE SHEAR STRESS ISF6.0,48H LBS/SQ IN.  THE ALLOWABLE STRESS        1
     3IN CONCRETE ISF7.0,10H LBS/SQ IN)                                        1
47    FORMAT (1H110X,16A5)                                                     1
48    FORMAT (53H0CONC STRNGTH  STEEL STRESS  TOTAL SHEAR  AXIAL FORCE5X       1
     147HMOMENT   TOTAL DEPTH  WIDTH     DEPTH      DEPTH/5X,4HF(C)10X,4H      1
     2F(S)11X,1HV12X1HN12X1HM11X1HD9X1HB9X1HD9X2HDP/12H  LBS/ SQ IN4X10H       1
     3LBS/ SQ IN7X4HKIPS9X4HKIPS8X6HKIP FT7X4HINCH7X2HIN8X2HIN8X2HIN/F10       1
     4.0,F14.0,F14.2,F13.2,F14.2,4F10.2)                                       1
49    FORMAT (22H0LENGTH IN COMPRESSIONF7.2,3H IN//19H ALLOWABLE SHEAR I       1
     1SF7.0,25H LBS/SQ IN  UNIT SHEAR ISF6.0,10H LBS/SQ IN//28H ALLOW ST       1
     2RESS IN CONCRETE ISF7.0,33H LBS/SQ IN  STRESS IN CONCRETE ISF7.0,1       1
     30H LBS/SQ IN//19H AREA TENSILE REINFF7.2,15H SQ IN   STRESSF8.0,10       1
     4H LBS/SQ IN//19H AREA COMPRSV REINFF7.2,15H SQ IN   STRESSF8.0,10H       1
     5 LBS/SQ IN)                                                              1
      END                                                                      1
// DUP
*STORE      WS  UA  M1A1
// FOR
*LIST ALL
      SUBROUTINE TPOLY (X,ZZ,EPS,ITEND)
```

```
      COMMON CFB,CFC,CFD,XL,XR,IER,CK,RFC,B,V,AMF
      IER=0
      X=XL
      FL=ZZ(X)
      IF (FL) 1,23,1
1     X=XR
      FR=ZZ(X)
      IF (FR) 2,23,2
2     IF (FL*FR) 4,3,3
3     IER=1
      X=.5*(XL+X)
      RETURN
4     IT=ITEND+1
      DO 22 N=1,IT
      DO 12 K=1,ITEND
      X=.5*(XL+XR)
      F=ZZ(X)
      IF (F) 5,23,5
5     IF (F*FR) 6,7,7
6     DX=XL
      XL=XR
      XR=DX
      DX=FL
      FL=FR
      FR=DX
7     IF (ABS(F)-ABS(FR)) 8,9,9
8     IF (N-IT) 15,9,9
9     XR=X
      FR=F
      DX=ABS(XR-XL)
      ABSXR=ABS(XR)
      IF (ABSXR-1.) 11,11,10
10    DX=DX/ABSXR
11    IF (DX-EPS) 13,13,12
12    CONTINUE
      IER=2
13    X=XL
      IF (ABS(FL)-ABS(FR)) 23,23,14
14    X=XR
      RETURN
15    DFL=F-FL
      DFR=FR-F
      DX=(X-XL)*FL*(1.+F*(DFR-DFL)/(DFR*(FR-FL)))/DFL
      XM=X
      FM=F
      X=XL-DX
      DX=ABS(DX)
      ABSX=ABS(X)
      IF (ABSX-1.) 17,17,16
16    DX=DX/ABSX
17    IF (DX-EPS) 23,23,18
18    F=ZZ(X)
      IF (F) 19,23,19
19    IF (F*FL) 20,20,21
20    XR=X
      FR=F
      GO TO 22
21    XL=X
      FL=F
      XR=XM
      FR=FM
22    CONTINUE
```

```
23    RETURN
      END
// DUP
*STORE      WS  UA  TPOLY
// FOR
*LIST ALL
      FUNCTION ZZ (X)
      COMMON B,C,D,XL,XR,IER,CK,RFC,S,V,AMF
      ZZ=((X+B)*X+C)*X+D
      RETURN
      END
// DUP
*STORE      WS  UA  ZZ
// FOR
*LIST ALL
      FUNCTION ZY (X)
      COMMON CFB,CFC,CFD,XL,XR,IER,C,RFC,B,V,AMF
      ZY=((X+2.)*X+(1.-3./C))*X-2./C
      RETURN
      END
// DUP
*STORE      WS  UA  ZY
// FOR
*LIST ALL
      FUNCTION AVB (X)
      COMMON CFB,CFC,CFD,XL,XR,IER,CK,RFC,B,V,AMF
      AVB=RFC+13./1.44*X/B*V/AMF
      RETURN
      END
// DUP
*STORE      WS  UA  AVB
// FOR
      FUNCTION ROOT (B,C)
      ROOT=(SQRT(B**2-4.*C)-B)/2.
      RETURN
      END
// DUP
*STORE      WS  UA  ROOT
// XEQ M1A1
```

```
          SAMPLE     PROBLEM FOR   1A1

CONC STRNGTH  STEEL STRESS  TOTAL SHEAR  AXIAL FORCE     MOMENT   TOTAL DEPTH  WIDTH       DEPTH       DEPTH
    F(C)          F(S)           V            N             M          D          B           D           DP
 LBS/ SQ IN    LBS/ SQ IN       KIPS         KIPS        KIP FT       INCH        IN          IN          IN
    3000.        20000.         10.00        10.00       100.00      24.00      12.00       22.00        2.00

LENGTH IN COMPRESSION    8.41 IN

ALLOWABLE SHEAR IS     58. LBS/SQ IN  UNIT SHEAR IS   38. LBS/SQ IN

ALLOW STRESS IN CONCRETE IS  1350. LBS/SQ IN  STRESS IN CONCRETE IS  1343. LBS/SQ IN

AREA TENSILE REINF   2.89 SQ IN   STRESS  19971. LBS/SQ IN

AREA COMPRSV REINF    .00 SQ IN   STRESS      0. LBS/SQ IN
```

LISTING AND SAMPLE OUTPUT FOR 1.A.2
"Composite Beam Section Properties"

```
// JOB 1
// FOR
*IOCS(CARD,1132PRINTER,DISK)
C     PROGRAM FOR FINDING SECTION PROPERTIES OF COMPOSITE SECTIONS      1A2
C     MEANING OF OUTPUT TERMS                                           1A2
C                                                                       1A2
C     N-MODULAR RATIO                                                   1A2
C     W/F - WEIGHT OF STEEL PER FOOT OF BEAM                            1A2
C     I - MOMENT OF INERTIA                                             1A2
C     STF - SECTION MODULUS TO TOP FLANGE                               1A2
C     SBF - SECTION MODULUS TO BOTTOM FLANGE                            1A2
C     SC - SECTION MODULUS TO TOP OF CONCRETE                           1A2
C     M - MOMENT OF TRANSFORMED CONCRETE SECTION ABOUT NEUTRAL AXIS     1A2
C                                                                       1A2
C                                                                       1A2
C     A1 - AREA OF BOTTOM FLANGE                                        1A2
C     A2 - AREA OF WEB                                                  1A2
C     A3 - AREA OF TOP FLANGE                                           1A2
C     A4 - AREA OF TRANSFORMED CONCRETE SLAB                            1A2
C     A1YS - AY OF BOTTOM FLANGE FOR NON COMPOSITE SECTION              1A2
C     A2YS - AY OF WEB FOR NON COMPOSITE SECTION                        1A2
C     A3YS - AY OF TOP FLANGE FOR NON COMPOSITE SECTION                 1A2
C     A4YT  - AY OF CONCRETE SLAB FOR COMPOSITE SECTION                 1A2
C     ASYT - AY OF STEEL FOR COMPOSITE SECTION                          1A2
C     ATS - AREA OF STEEL                                               1A2
C     AYTSC - AY OF COMPOSITE SECTION                                   1A2
C     D1 - DEPTH OF BOTTOM FLANGE                                       1A2
C     D2 - DEPTH OF WEB                                                 1A2
C     D3 - DEPTH OF TOP FLANGE                                          1A2
C     D4 - DEPTH OF SLAB                                                1A2
C     DI1  - NAME OF ARRAY FOR GENERATING D1                            1A2
C     DI4  - NAME OF ARRAY FOR GENERATING D4                            1A2
C     DI2 - NAME OF ARRAY FOR READING D2                                1A2
C     ID - IF 0 USE T1 ROUTINE IF 1 USE W1 ROUTINE                      1A2
C     L - COUNTER FOR PRINTING OF TITLE                                 1A2
C     NID1 - NUMBER OF DEPTHS OF BOTTOM FLANGE BEING READ               1A2
C     NID4 - NUMBER OF DEPTHS OF SLAB BEING READ                        1A2
C     NIT1 - NUMBER OF T1 BEING READ                                    1A2
C     NIW1 - NUMBER OF WIDTHS OF BOTTOM FLANGE BEING READ               1A2
C     NIWT - DUMMY VARIBLE FOR SETTING UP DO LOOP                       1A2
C     NOFW2 - NUMBER OF DEPTHS AND WIDTHS OF WEB BEING READ             1A2
C     SBF - SECTION MODULUS TO BOTTOM FLANGE                            1A2
C     SC - SECTION MODULUS TO CONCRETE                                  1A2
C     STF - SECTION MODULUS TO TOP FLANGE                               1A2
C     SID1 - SIZE OF INCREMENTS OF DEPTH OF BOTTOM FLANGE               1A2
C     SID4 - SIZE OF INCREMENTS OF DEPTH OF SLAB                        1A2
C     SIT1 - SIZE OF INCREMENTS OF T1                                   1A2
C     SIW1 - SIZE OF INCREMENTS OF WIDTH OF BOTTOM FLANGE               1A2
C     T1 - NUMBER DEPTH OF BOTTOM FLANGE IS MULTIPLIED BY TO GET WIDTH  1A2
C     T4 - NUMBER DEPTH OF CONCRETE IS MULTIPLIED BY TO GET WIDTH W4    1A2
C     TI1  - NAME OF ARRAY FOR GENERATING T1                            1A2
C     W - WEIGHT PER FOOT OF STEEL                                      1A2
C     W1 - WIDTH OF BOTTOM FLANGE                                       1A2
C     W2 - WIDTH OF WEB                                                 1A2
C     W3 - WIDTH OF TOP FLANGE                                          1A2
C     W4 - WIDTH OF SLAB                                                1A2
C     WI1 - NAME OF ARRAY FOR GENERATING W1                             1A2
C     WI2 - NAME OF ARRAY FOR READING W2                                1A2
C     XI - I OF STEEL SECTION                                           1A2
C     XIC - I OF CONCRETE FOR COMPOSITE SECTION                         1A2
C     XIBF - I OF BOTTOM FLANGE FOR NON COMPOSITE SECTION               1A2
C     XITF - I OF TOP FLANGE FOR NON COMPOSITE SECTION                  1A2
```

```
C     XIS - I OF STEEL FOR COMPOSITE SECTION                            1A2
C     XIT - I OF COMPOSITE SECTION                                      1A2
C     XIW  - I OF WEB FOR NON COMPOSITE SECTION                         1A2
C     XM - MOMENT OF TRANSFORMED CONCRETE SECTION ABOUT NEUTRAL AXIS    1A2
C     XN - MODULAR RATIO                                                1A2
C     YS - DISTANCE TO NEUTRAL AXIS FROM TOP FLANGE FOR NON COMPOSITE SE1A2
C     YST - DISTANCE TO NEUTRAL AXIS FROM CONCRETE FOR COMPOSITE SECTION1A2
      DIMENSION DI2(300), WI2(300), DI4(300), DI1(300), TI1(300), A(8)  1A2
      DIMENSION WI1(300)                                                1A2
      COMMON W4,W2,XN,W3,D3,D4,D2,A,L                                   1A2
1     READ (2,21) A                                                     1A2
      READ (2,22) XN,NOFW2,ID                                           1A2
      READ (2,23) W3,D3                                                 1A2
      READ (2,24) D4,NID4,SID4,T4                                       1A2
      READ (2,24) D1,NID1,SID1                                          1A2
      IF (ID) 20,2,4                                                    1A2
2     READ (2,24) T1,NIT1,SIT1                                          1A2
      TI1(1)=T1                                                         1A2
      DO 3 J=1,NIT1                                                     1A2
3     TI1(J+1)=TI1(J)+SIT1                                              1A2
      GO TO 6                                                           1A2
4     READ (2,24) W1,NIW1,SIW1                                          1A2
      WI1(1)=W1                                                         1A2
      DO 5 I=1,NIW1                                                     1A2
5     WI1(I+1)=WI1(I)+SIW1                                              1A2
6     READ (2,25) (WI2(N),DI2(N),N=1,NOFW2)                             1A2
      L=0                                                               1A2
      DI4(1)=D4                                                         1A2
      DO 7 M=1,NID4                                                     1A2
7     DI4(M+1)=DI4(M)+SID4                                              1A2
      DI1(1)=D1                                                         1A2
      DO 8 K=1,NID1                                                     1A2
8     DI1(K+1)=DI1(K)+SID1                                              1A2
      A3=W3*D3                                                          1A2
      A3YS=A3*(D3/2.)                                                   1A2
      DO 19 M=1,NID4                                                    1A2
      D4=DI4(M)                                                         1A2
C     IF T4 = 0, PROGRAM SUPPLIES T4 = 16*D4+W3 PER AISC SPECS          1A2
C     IF T4 = XX, PROGRAM USES XX TO FIND W4 (W4 = T4*D4)               1A2
      IF (T4) 9,9,10                                                    1A2
9     W4=D4*16.+W3                                                      1A2
      GO TO 11                                                          1A2
10    W4=D4*T4                                                          1A2
11    CONTINUE                                                          1A2
      A4=W4*D4/XN                                                       1A2
      A4YT=A4*(D4/2.)                                                   1A2
      DO 19 N=1,NOFW2                                                   1A2
      D2=DI2(N)                                                         1A2
      W2=WI2(N)                                                         1A2
      A2=D2*W2                                                          1A2
      A2YS=A2*(D3+(D2/2.))                                              1A2
      CALL TITLE                                                        1A2
      DO 19 K=1,NID1                                                    1A2
      D1=DI1(K)                                                         1A2
      IF (ID) 20,12,13                                                  1A2
12    NIWT=NIT1                                                         1A2
      GO TO 14                                                          1A2
13    NIWT=NIW1                                                         1A2
14    DO 19 JTW=1,NIWT                                                  1A2
      IF (ID) 19,15,16                                                  1A2
15    T1=TI1(JTW)                                                       1A2
      W1=D1*T1                                                          1A2
```

```
      GO TO 17                                                           1A2
16    W1=W11(JTW)                                                        1A2
17    A1=D1*W1                                                           1A2
      A1YS=A1*(D3+D2+D1/2.)                                              1A2
      A1YST=A1YS+A2YS+A3YS                                               1A2
      ATS=A1+A2+A3                                                       1A2
      YS=A1YST/ATS                                                       1A2
      XITF=A3*((D3*D3)/12.+(YS-D3/2.)*(YS-D3/2.))                        1A2
      XIW=A2*((D2*D2)/12.+(YS-D3-D2/2.)*(YS-D3-D2/2.))                   1A2
      XIBF=A1*((D1*D1)/12.+(D2+D3+D1/2.-YS)*(D2+D3+D1/2.-YS))            1A2
      XI=XITF+XIW+XIBF                                                   1A2
      STF=XI/YS                                                          1A2
      SBF=XI/(D3+D2+D1-YS)                                               1A2
      W=ATS*490./144.                                                    1A2
      WRITE (3,26) D1,W1,A1,W,XI,STF,SBF                                 1A2
      ASYT=ATS*(YS+D4)                                                   1A2
      AYTSC=A4YT+ASYT                                                    1A2
      YST=AYTSC/(ATS+A4)                                                 1A2
      XIC=A4*(D4*D4/12.+(YST-D4/2.)*(YST-D4/2.))                         1A2
      XIS=XI+ATS*(YS+D4-YST)*(YS+D4-YST)                                 1A2
      XIT=XIC+XIS                                                        1A2
      STF=XIT/(YST-D4)                                                   1A2
      SBF=XIT/(D4+D3+D2+D1-YST)                                          1A2
      SC=XIT/YST                                                         1A2
      XM=A4*(YST-D4/2.)                                                  1A2
      WRITE (3,27) XIT,STF,SBF,SC,XM                                     1A2
      L=L+1                                                              1A2
      IF (L-46) 19,18,18                                                 1A2
18    CALL TITLE                                                         1A2
19    CONTINUE                                                           1A2
20    CONTINUE                                                           1A2
      GO TO 1                                                            1A2
C                                                                        1A2
21    FORMAT (8A10)                                                      1A2
22    FORMAT (F5.2,2I5)                                                  1A2
23    FORMAT (2F10.3)                                                    1A2
24    FORMAT (F10.3,I10,2F10.3)                                          1A2
25    FORMAT (2F10.3)                                                    1A2
26    FORMAT (1H ,F8.3,1H(,F9.3,1H(,F9.2,1H(,F9.2,1H(,F10.1,1H(F9.1,1H(F1A2
     19.1,1H()                                                           1A2
27    FORMAT (1H+,70X,F10.1,1H(,F9.1,1H(,F9.1,1H(,F9.1,1H(,F9.2)         1A2
      END                                                                1A2
// DUP
*STORE      WS  UA  M1A2
// FOR
      SUBROUTINE TITLE
      DIMENSION A(8)
      COMMON W4,W2,XN,W3,D3,D4,D2,A,L
      WRITE (3,1)
      WRITE (3,13) A
      WRITE (3,2)
      WRITE (3,3)
      WRITE (3,4) W4,W2
      WRITE (3,5)
      WRITE (3,6) XN,W3,D3
      WRITE (3,7) D4,D2
      WRITE (3,5)
      WRITE (3,3)
      WRITE (3,12)
      WRITE (3,8)
      WRITE (3,9)
      WRITE (3,8)
```

```
      WRITE (3,12)
      WRITE (3,10)
      WRITE (3,10)
      WRITE (3,11)
      WRITE (3,10)
      WRITE (3,12)
      WRITE (3,10)
      L=0
      RETURN
C
1     FORMAT (1H1)
2     FORMAT (121H .....................................................
     1..................................................................
     2.)
3     FORMAT (16X,1H(,34X,1H(,34X,1H()
4     FORMAT (1H ,15X,1H(,15X,8HWIDTH = ,F8.3,3X,1H(,14X,8HWIDTH = F8.3)
5     FORMAT (1H+,85X,1H()
6     FORMAT (5X,4HN = ,F6.2,3X,12H(   CONCRETE,23X,8H(     WEB,27X,13H(
     1 TOP FLANGE,2X,F8.3,2H X,F8.3)
7     FORMAT (1H ,15X,1H(,15X,8HDEPTH = ,F8.3,3X,1H(,14X,8HDEPTH = ,F8.3
     1)
8     FORMAT (29X,1H(,40X,1H()
9     FORMAT (8X,14HBOTTOM  FLANGE,7X,1H(,8X,23HNON  COMPOSITE  SECTION,
     19X,1H(,16X,18HCOMPOSITE  SECTION)
10    FORMAT (9X,1H(,9X,1H(,9X,1H(,9X,1H(,10X,1H(,9X,1H(,9X,1H(,10X,1H(,
     19X,1H(,9X,1H(,9X,1H()
11    FORMAT (1H+,1X,5HDEPTH,5X,5HWIDTH,5X,4HAREA,6X,4HW/FT,8X,1HI,9X,3H
     1STF,7X,3HSBF,8X,1HI,9X,3HSTF,7X3HSBF,7X2HSC,9X,1HM)
12    FORMAT (121H+.....................................................
     1..................................................................
     2.)
13    FORMAT (1X,8A10)
      END
// DUP
*STORE      WS  UA  TITLE
// XEQ M1A2
```

```
     SAM    PROBLM    OR 1A2
.......................................................................................................
            (                         (                        (
  N =  10.00 (  CONCRETE  WIDTH =  72.000 (  WEB  WIDTH =   .375 (  TOP FLANGE   8.000 X   .500
            (             DEPTH =   6.000 (       DEPTH = 24.000 (
.......................................................................................................
                          (                                     (
      BOTTOM  FLANGE      (     NON  COMPOSITE  SECTION          (        COMPOSITE  SECTION
.......................................................................................................
         (         (      (        (        (        (         (        (        (        (
 DEPTH   (  WIDTH  (  AREA (  W/FT  (   I    (  STF   (  SBF    (   I    (  STF   (  SBF   (  SC    (   M
.......................................................................................................
         (         (      (        (        (        (         (        (        (        (
   1.000(  12.000(  12.00(  85.07(  2500.3(  151.2(  279.1(  8676.2(  2084.2(  406.6(  853.7(  309.43
```

LISTING AND SAMPLE OUTPUT FOR 1.A.3

"Concrete Beam Review"

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
C       REVIEW OF SIMPLE CONCRETE BEAM
        READ (2,2) FS,FC,AN
        READ (2,2) AS,B,D
        P=AS/(B*D)
        AK=(((2.0*P*AN)+((P*AN)**2.0))**0.5)-(P*AN)
        AJ=1.0-(AK/3.0)
        AMS=(AS*FS*AJ*D)/12000.0
        AMC=(FC*0.5*AK*AJ*B*(D**2.0))/12000.0
        WRITE (3,3)
        WRITE (3,4)
        WRITE (3,1) FS,FC,AN,AS,B,D
        WRITE (3,5)
        WRITE (3,1) P,AK,AJ,AMS,AMC
        WRITE (3,3)
        WRITE (3,3)
        WRITE (3,6)
C
1       FORMAT (1X,6F12.4)
2       FORMAT (3F10.0)
3       FORMAT (1X,1H )
4       FORMAT (7X,2HFS,10X,2HFC,11X,1HN,10X,2HAS,11X,1HB,11X,1HD)
5       FORMAT (5X,1HP,11X,1HK,11X,1HJ,10X,2HMS,10X,2HMC)
6       FORMAT (1H1)
        END
// DUP
*STORE      WS  UA  MIAS
// XEQ MIAS
// JOB
```

```
      FS           FC            N          AS          B          D
  20000.0000   1350.0000     10.0000      6.9300     17.0000    31.0000
      P            K             J          MS          MC
     .0131        .3979        .8674     310.5576    317.1720
```

LISTING AND SAMPLE OUTPUT FOR 1.B.1

"Biaxial Bending of Rectangular Columns"

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
C     RECT. CONCRETE COLUMN WITH BIAXIAL BENDING                        1B1
      REAL MALLA,MALLB                                                  1B1
      DIMENSION ACORX(100), ACORY(100), AREA(100), TAREA(100), BARNO(1001B1
     1)                                                                 1B1
1     READ (2,41) ENGR,DATE                                             1B1
      READ (2,40) T,D,XMX,XMY,THR,EN                                    1B1
      DO 2 I=1,100                                                      1B1
      ACORX(I)=0.0                                                      1B1
      ACORY(I)=0.0                                                      1B1
      AREA(I)=0.0                                                       1B1
2     TAREA(I)=0.0                                                      1B1
      I=1                                                               1B1
3     READ (2,40) BARNO(I),ACORX(I),ACORY(I),AREA(I)                    1B1
      I=I+1                                                             1B1
      IF (BARNO(I-1)-100.) 3,4,4                                        1B1
4     NOBAR=I-1                                                         1B1
      N=1                                                               1B1
      JJ=1                                                              1B1
      NCOMP=1                                                           1B1
5     WRITE (3,43)                                                      1B1
      WRITE (3,75)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,72) ENGR,DATE                                            1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,41)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,48)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,52)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,49)                                                      1B1
      WRITE (3,50)                                                      1B1
      WRITE (3,51)                                                      1B1
      WRITE (3,53) T,D,XMX,XMY,THR,EN                                   1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,54)                                                      1B1
      WRITE (3,55)                                                      1B1
      WRITE (3,57)                                                      1B1
      DO 6 I=1,NOBAR                                                    1B1
6     WRITE (3,56) BARNO(I),ACORX(I),ACORY(I),AREA(I)                   1B1
7     A=T*D                                                             1B1
      WRITE (3,43)                                                      1B1
      WRITE (3,73)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,72) ENGR,DATE                                            1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,41)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,48)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,58)                                                      1B1
      WRITE (3,42)                                                      1B1
      QOX=.5*T**2*D                                                     1B1
      QOY=.5*T*D**2                                                     1B1
      ERTOX=(T**3/3.)*D                                                 1B1
      ERTOY=(T/3.)*D**3                                                 1B1
      ERTXY=(T**2/4.)*D**2                                              1B1
      ESUBX=XMY*12./THR                                                 1B1
      ESUBY=XMX*12./THR                                                 1B1
```

```
      XSUBP=D/2.-ESUBX                                                  1B1
      YSUBP=T/2.-ESUBY                                                  1B1
      RATIO=ESUBX/D+ESUBY/T                                             1B1
8     SMAL1=(ERTXY-YSUBP*QOY)*(ERTXY-XSUBP*QOX)-(ERTOX-YSUBP*QOX)*(ERTOY1B1
     1-XSUBP*QOY)                                                       1B1
      MALLA=SMAL1/((QOX-YSUBP*A)*(ERTXY-XSUBP*QOX)-(QOY-XSUBP*A)*(ERTOX-1B1
     1YSUBP*QOX))                                                       1B1
      MALLB=SMAL1/((QOY-XSUBP*A)*(ERTXY-YSUBP*QOY)-(QOX-YSUBP*A)*(ERTOY-1B1
     1XSUBP*QOY))                                                       1B1
      SLOPE=MALLA/MALLB                                                 1B1
      AREAT=0.0                                                         1B1
      AREAC=0.0                                                         1B1
      DO 13 I=1,NOBAR                                                   1B1
      TAREA(I)=0.0                                                      1B1
      STOR1=MALLA-ACORY(I)*SLOPE                                        1B1
      GO TO (10,9), NCOMP                                               1B1
9     IF (STOR1-ACORX(I)) 12,12,13                                      1B1
10    IF (STOR1-ACORX(I)) 12,12,11                                      1B1
11    TAREA(I)=(2.*EN-1.)*AREA(I)                                       1B1
      AREAC=AREAC+TAREA(I)                                              1B1
      GO TO 13                                                          1B1
12    TAREA(I)=EN*AREA(I)                                               1B1
      AREAT=AREAT+TAREA(I)                                              1B1
13    CONTINUE                                                          1B1
      QOX=0.0                                                           1B1
      QOY=0.0                                                           1B1
      ERTOX=0.0                                                         1B1
      ERTOY=0.0                                                         1B1
      ERTXY=0.0                                                         1B1
      DO 14 I=1,NOBAR                                                   1B1
      QOX=QOX+TAREA(I)*ACORY(I)                                         1B1
      QOY=QOY+TAREA(I)*ACORX(I)                                         1B1
      ERTOX=ERTOX+TAREA(I)*ACORY(I)**2                                  1B1
      ERTOY=ERTOY+TAREA(I)*ACORX(I)**2                                  1B1
      ERTXY=ERTXY+TAREA(I)*ACORY(I)*ACORX(I)                            1B1
14    CONTINUE                                                          1B1
      T1=MALLA*MALLB                                                    1B1
      T2=(MALLB-T)/MALLB                                                1B1
      T3=(MALLA-D)/MALLA                                                1B1
      IF (MALLA-D) 15,15,16                                             1B1
15    IF (MALLB-T) 19,19,20                                             1B1
16    IF (MALLB-T) 21,21,17                                             1B1
17    IF (MALLA*((MALLB-T)/MALLB)-D) 22,18,18                           1B1
18    IF (MALLB*((MALLA-D)/MALLA)-T) 22,23,23                           1B1
C     CASE I FOLLOWS                                                    1B1
19    A=.5*T1+AREAC+AREAT                                               1B1
      QOX=QOX+(T1*MALLB)/6.                                             1B1
      QOY=QOY+(T1*MALLA)/6.                                             1B1
      ERTOX=ERTOX+(T1*MALLB**2)/12.                                     1B1
      ERTOY=ERTOY+(T1*MALLA**2)/12.                                     1B1
      ERTXY=ERTXY+(T1*T1)/24.                                           1B1
      GO TO 24                                                          1B1
C     CASE II FOLLOWS                                                   1B1
20    A=.5*T1*(1.-(T2)**2)+AREAC+AREAT                                  1B1
      QOX=QOX+MALLA*T**2*(3.-2.*T/MALLB)/6.                             1B1
      QOY=QOY+MALLA**2*MALLB*(1.-T2**3)/6.                              1B1
      ERTOX=ERTOX+MALLA*T**3*(4.-3.*T/MALLB)/12.                        1B1
      ERTOY=ERTOY+MALLA**3*MALLB*(1.-T2**4)/12.                         1B1
      ERTXY=ERTXY+T1**2*(1.-T2**4-4.*T2**3*T/MALLB)/24.                 1B1
      GO TO 24                                                          1B1
C     CASE III FOLLOWS                                                  1B1
21    A=.5*T1*(1.-T3**2)+AREAC+AREAT                                    1B1
```

```
      QOX=QOX+T1*MALLB*(1.-T3**3)/6.                                    1B1
      QOY=QOY+MALLB*D**2*(3.-2.*D/MALLA)/6.                             1B1
      ERTOX=ERTOX+T1*MALLB**2*(1.-T3**4)/12.                            1B1
      ERTOY=ERTOY+MALLB*D**3*(4.-3.*D/MALLA)/12.                        1B1
      ERTXY=ERTXY+T1**2*(1.-T3**4-4.*T3**3*D/MALLA)/24.                 1B1
      GO TO 24                                                          1B1
C     CASE IV FOLLOWS                                                   1B1
22    A=.5*T1*(1.-T3**2-T2**2)+AREAC+AREAT                              1B1
      QOX=QOX+T1*MALLB*(1.-T3**3-T2**3-3.*T2**2*T/MALLB)/6.             1B1
      QOY=QOY+T1*MALLA*(1.-T3**3-T2**3-3.*T3**2*D/MALLA)/6.             1B1
      ERTOX=ERTOX+T1*MALLB**2*(1.-T3**4-T2**4-2.*T2**2*(T/MALLB)*((2.*MA1B1
     1LLB+T)/MALLB))/12.                                                1B1
      ERTOY=ERTOY+T1*MALLA**2*(1.-T3**4-T2**4-2.*T3**2*(D/MALLA)*((2.*MA1B1
     1LLA+D)/MALLA))/12.                                                1B1
      ERTXY=ERTXY+T1**2*(1.-T3**4-T2**4-4.*T3**3*(D/MALLA)-4.*T2**3*(T/M1B1
     1ALLB))/24.                                                        1B1
      GO TO 24                                                          1B1
C     CASE V FOLLOWS                                                    1B1
23    A=D*T+AREAC+AREAT                                                 1B1
      QOX=QOX+.5*D*T**2                                                 1B1
      QOY=QOY+.5*D**2*T                                                 1B1
      ERTOX=ERTOX+D*T**3/3.                                             1B1
      ERTOY=ERTOY+D**3*T/3.                                             1B1
      ERTXY=ERTXY+D**2*T**2/4.                                          1B1
24    GO TO (25,26), N                                                  1B1
25    SMALA=MALLA                                                       1B1
      SMALB=MALLB                                                       1B1
      N=2                                                               1B1
      GO TO 8                                                           1B1
26    JJ=JJ+1                                                           1B1
      IF (JJ-50) 27,27,29                                               1B1
27    TSMLA=ABS(MALLA-SMALA)                                            1B1
      TSMLB=ABS(MALLB-SMALB)                                            1B1
      IF (TSMLA-.005) 28,25,25                                          1B1
28    IF (TSMLB-.005) 29,25,25                                          1B1
29    CSTR=THR*1000./(A-(QOY/MALLA)-(QOX/MALLB))                        1B1
      WRITE (3,59) RATIO                                                1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,62) ESUBX                                                1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,63) ESUBY                                                1B1
      WRITE (3,42)                                                      1B1
      GO TO (131,132),NCOMP
  131 WRITE (3,64)                                                      1B1
      WRITE (3,42)                                                      1B1
      GO TO 133
  132 WRITE (3,65)                                                      1B1
      WRITE (3,42)                                                      1B1
  133 WRITE (3,45) JJ                                                   1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,60) MALLA                                                1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,61) MALLB                                                1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,69)                                                      1B1
      WRITE (3,70)                                                      1B1
      WRITE (3,71) A,ERTOX,ERTOY                                        1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,44) CSTR                                                 1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,66)                                                      1B1
```

```
      WRITE (3,67)                                                      1B1
      WRITE (3,68)                                                      1B1
      LINE=1                                                            1B1
      DO 36 I=1,NOBAR                                                   1B1
      GO TO (31,30), NCOMP                                              1B1
30    IF (TAREA(I)) 36,36,31                                            1B1
31    IF (AREA(I)*EN-TAREA(I)) 33,32,32                                 1B1
32    FS=EN*CSTR*(1.-(ACORX(I)/MALLA)-(ACORY(I)/MALLB))                 1B1
      WRITE (3,46) I,FS                                                 1B1
      GO TO 34                                                          1B1
33    FPS=2.*EN*CSTR*(1.-ACORX(I)/MALLA-(ACORY(I)/MALLB))               1B1
      WRITE (3,47) I,FPS                                                1B1
34    LINE=LINE+1                                                       1B1
      IF (LINE-25) 36,36,35                                             1B1
35    LINE=1                                                            1B1
      WRITE (3,43)                                                      1B1
      WRITE (3,73)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,72) ENGR,DATE                                            1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,41)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,48)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,58)                                                      1B1
      WRITE (3,42)                                                      1B1
      WRITE (3,66)                                                      1B1
      WRITE (3,67)                                                      1B1
      WRITE (3,68)                                                      1B1
36    CONTINUE                                                          1B1
      WRITE (3,42)                                                      1B1
      GO TO (37,38), NCOMP                                              1B1
37    NCOMP=2                                                           1B1
      N=1
      JJ=1                                                              1B1
      GO TO 7                                                           1B1
38    READ (2,40) XLOAD                                                 1B1
      IF (XLOAD) 39,1,39                                                1B1
39    READ (2,41) ENGR,DATE                                             1B1
      READ (2,41) ENGR,DATE                                             1B1
      NCOMP=1                                                           1B1
      N=1                                                               1B1
      JJ=1                                                              1B1
      GO TO 5                                                           1B1
C                                                                       1B1
40    FORMAT (8F10.3)                                                   1B1
41    FORMAT (68H                                                       1B1
     1                    ,A5,A6)                                       1B1
42    FORMAT (1X)                                                       1B1
43    FORMAT (1H1)                                                      1B1
44    FORMAT (2X,25HMAXIMUM CONCRETE STRESS =,F8.1,5H(PSI))             1B1
45    FORMAT (2X,53HNUMBER OF PASSES REQUIRED FOR NEUTRAL AXIS SOLUTION 1B1
     1=,I4)                                                             1B1
46    FORMAT (18X,I4,F14.1,2X,7HTENSILE)                                1B1
47    FORMAT (18X,I4,F14.1,2X,11HCOMPRESSIVE)                           1B1
48    FORMAT (11X,54HB1AXIAL BENDING - WORKING STRESS - PROGRAM(13=R3=C11B1
     118))                                                              1B1
49    FORMAT (2X,73HMEMBER HEIGHT  MEMBER WIDTH  MOMENT ABT.  MOMENT ABT1B1
     1.  THRUST AT  MODULAR)                                            1B1
50    FORMAT (2X,72HALONG Y-AXIS   ALONG X-AXIS  X=AXIS C.L.  Y-AXIS C.L1B1
     1.    C.L.      RATIO)                                             1B1
51    FORMAT (3X,61H(INCHES)         (INCHES)       (KIP-FT)      (KIP=FT)  1B1
```

```
      1    (KIPS))                                                          1B1
52     FORMAT (1X,75H*********************************  INPUT DATA  ******1B1
      1**********************)                                              1B1
53     FORMAT (1X,F11.3,F15.3,F13.3,F13.3,F12.3,F10.2)                     1B1
54     FORMAT (17X,46HDESIGNATED  BAR    X-AXIS  BAR    Y-AXIS   BAR)     1B1
55     FORMAT (17X,42HBAR NUMBER   COORDINATE  COORDINATE   AREA)          1B1
56     FORMAT (19X,F5.0,F16.3,F13.3,F11.2)                                 1B1
57     FORMAT (33X,30H(INCHES)   (INCHES)   (SQ,IN.))                      1B1
58     FORMAT (1X,72H******************************  OUTPUT  ***********1B1
      1********************)                                                1B1
59     FORMAT (2X,53HSUM OF ECCENTRICITY TO THICKNESS IN BOTH DIRECTIONS 1B1
      1=,F5.3)                                                              1B1
60     FORMAT (2X,38HTHE NEUTRAL AXIS INTERSECTS THE X-AXIS,F8.2,24H(INCH1B1
      1 S) FROM THE ORIGIN)                                                 1B1
61     FORMAT (2X,38HTHE NEUTRAL AXIS INTERSECTS THE Y-AXIS,F8.2,24H(INCH1B1
      1 S) FROM THE ORIGIN)                                                 1B1
62     FORMAT (2X,48HTHE ECC. FROM C.L. OF MEMBER ALONG THE X-AXIS = ,F7.1B1
      12,8H(INCHES))                                                        1B1
63     FORMAT (2X,48HTHE ECC. FROM C.L. OF MEMBER ALONG THE Y-AXIS = ,F7.1B1
      12,8H(INCHES))                                                        1B1
64     FORMAT (2X,70HALL COMPRESSIVE REINFORCEMENT IS TRANSFORMED FOR NEU1B1
      1TRAL AXIS SOLUTION)                                                  1B1
65     FORMAT (2X,66HALL COMPRESSIVE REINFORCEMENT IS IGNORED FOR NEUTRAL1B1
      1 AXIS SOLUTION)                                                      1B1
66     FORMAT (17X,8HCOMPUTER,15X,4HTYPE)                                  1B1
67     FORMAT (16X,29HDESIGNATED    STRESS   STRESS)                       1B1
68     FORMAT (16X,19HBAR NUMBER    (PSI))                                 1B1
69     FORMAT (2X,57HPROPERTIES OF SECTION (EFF. CONCRETE + TRANSFORMED S1B1
      1TEEL))                                                               1B1
70     FORMAT (7X,4HAREA,8X,4HI(X),9X,4HI(Y))                              1B1
71     FORMAT (1X,F10.2,F12.1,F13.1)                                       1B1
72     FORMAT (50X,6HENGR, ,A3,6H DATE ,A8)                                1B1
73     FORMAT (50X,5HSHEET,5X,2HOF)                                        1B1
       END                                                                 1B1
// DUP
*STORE      WS  UA  M1B1
// XQT M1B1
// JOB
```

```
                                                                SHEET      OF

                                                                ENGR, EFC DATE   /12/68

TEST CASE NO 1 FOR SP-17        FOR 1B1

      -    BIAXIAL BENDING - WORKING STRESS - PROGRAM(13=R3=C118)

*******************************  INPUT DATA  ******************************

 MEMBER HEIGHT  MEMBER WIDTH  MOMENT ABT.  MOMENT ABT.  THRUST AT  MODULAR
 ALONG Y-AXIS   ALONG X-AXIS  X=AXIS C.L.  Y-AXIS C.L.     C.L.      RATIO
   (INCHES)       (INCHES)      (KIP-FT)     (KIP=FT)     (KIPS)
     17.000         25.000        22.693      113.467     68.080     10.00

                DESIGNATED  BAR    X-AXIS  BAR    Y-AXIS   BAR
                BAR NUMBER   COORDINATE  COORDINATE   AREA
                               (INCHES)    (INCHES)   (SQ.IN.)
                      1.          2.500       2.500        .79
                      2.         12.500       2.500        .79
                      3.         22.500       2.500        .79
                      4.          2.500       8.500        .79
                      5.         22.500       8.500        .79
                      6.          2.500      14.500        .79
                      7.         12.500      14.500        .79
                    100.         22.500      14.500        .79
```

```
                                                                SHEET       OF

                                                                ENGR,       DATE

EST CASE NO. 1 FOR 1B1

          BIAXIAL BENDING - WORKING STRESS - PROGRAM(13=R3=C118)

******************************  OUTPUT  ******************************

 SUM OF ECCENTRICITY TO THICKNESS IN BOTH DIRECTIONS =1.035

 THE ECC. FROM C.L. OF MEMBER ALONG THE X-AXIS =   20.00(INCHES)

 THE ECC. FROM C.L. OF MEMBER ALONG THE Y-AXIS =    4.00(INCHES)

 ALL COMPRESSIVE REINFORCEMENT IS TRANSFORMED FOR NEUTRAL AXIS SOLUTION

 NUMBER OF PASSES REQUIPED FOR NEUTRAL AXIS SOLUTION =   5

 THE NEUTRAL AXIS INTERSECTS THE X-AXIS   12.66(INCH S) FROM THE ORIGIN

 THE NEUTRAL AXIS INTERSECTS THE Y-AXIS   29.21(INCH S) FROM THE ORIGIN

 PROPERTIES OF SECTION (EFF. CONCRETE + TRANSFORMED STEEL)
      AREA         I(X)          I(Y)
    237.09      20007.0       19533.9

 MAXIMUM CONCRETE STRESS =  1350.0(PSI)


               COMPUTER                TYPE
              DESIGNATED     STRESS   STRESS
              BAR NUMBER     (PSI)
                   1        19356.7  COMPRESSIVE
                   2         -987.6  TENSILE
                   3       -11653.6  TENSILE
                   4        13811.1  COMPRESSIVE
                   5       -14426.4  TENSILE
                   6         8265.5  COMPRESSIVE
                   7        -6533.2  TENSILE
                   8       -17199.2  TENSILE
```

```
EST CASE NO. 1 FOR 181

          BIAXIAL BENDING - WORKING STRESS - PROGRAM(13=R3=C118)

******************************  OUTPUT  ******************************

 SUM OF ECCENTRICITY TO THICKNESS IN BOTH DIRECTIONS =1.035

 THE ECC. FROM C.L. OF MEMBER ALONG THE X-AXIS =   20.00(INCHES)

 THE ECC. FROM C.L. OF MEMBER ALONG THE Y-AXIS =    4.00(INCHES)

 ALL COMPRESSIVE REINFORCEMENT IS IGNORED FOR NEUTRAL AXIS SOLUTION

 NUMBER OF PASSES REQUIRED FOR NEUTRAL AXIS SOLUTION =   5

 THE NEUTRAL AXIS INTERSECTS THE X-AXIS   13.47(INCH S) FROM THE ORIGIN

 THE NEUTRAL AXIS INTERSECTS THE Y-AXIS   32.53(INCH S) FROM THE ORIGIN

 PROPERTIES OF SECTION (EFF. CONCRETE + TRANSFORMED STEEL)
      AREA        I(X)        I(Y)
    208.72     17410.5     20755.3

 MAXIMUM CONCRETE STRESS =  1699.4(PSI)


                COMPUTER                   TYPE
                DESIGNATED      STRESS    STRESS
                BAR NUMBER      (PSI)
                     2            -76.4   TENSILE
                     3        -12688.4   TENSILE
                     5        -15822.6   TENSILE
                     7         -6344.9   TENSILE
                     8        -18956.9   TENSILE
```

LISTING AND SAMPLE OUTPUT FOR 1.B.2

"Biaxial Bending of Irregular Columns"

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
C      WSD OF CONCRETE COLUMNS WITH BIAXIAL END MOMENTS (LOADS AND X-SEC1B2
C      CONSTANT WITH RESPECT TO LENGTH)                                 1B2
      DIMENSION XCON(100), YCON(100), AS(100), X1STL(100), Y1STL(100), B1B2
     1ARN(100), X2STL(100), Y2STL(100), FZ(100), TITLE(20), CODE(5)     1B2
      ICON1=1                                                           1B2
      ICON2=2                                                           1B2
      ICON3=3                                                           1B2
      ICON4=4                                                           1B2
      NCON1=1                                                           1B2
      NSTL1=1                                                           1B2
1     READ (2,103) TITLE                                                1B2
      READ (2,97) NCON,NSTL,NLD,ISWT1,ISWT2,ICLMT                       1B2
      IF (ICLMT) 3,2,3                                                  1B2
2     ICLMT=16                                                          1B2
3     IF (NCON) 10,10,4                                                 1B2
4     I=NCON1                                                           1B2
5     XCON(I)=0.                                                        1B2
      YCON(I)=0.                                                        1B2
      I=I-1                                                             1B2
      IF (NCON-I) 5,6,6                                                 1B2
6     DO 7 I=1,NCON,3                                                   1B2
      J=I+1                                                             1B2
      K=I+2                                                             1B2
7     READ (2,98) XCON(I),YCON(I),XCON(J),YCON(J),XCON(K),YCON(K)       1B2
      IF (XCON(1)-XCON(NCON)) 8,9,8                                     1B2
8     WRITE (3,113) TITLE                                               1B2
      WRITE (3,115)                                                     1B2
      GO TO 96                                                          1B2
9     IF (YCON(1)-YCON(NCON)) 8,10,8                                    1B2
10    IF (NSTL) 15,15,11                                                1B2
11    I=NSTL1                                                           1B2
12    AS(I)=0.                                                          1B2
      X1STL(I)-0.                                                       1B2
      Y1STL(I)=0.                                                       1B2
      BARN(I)=0.                                                        1B2
      X2STL(I)=0.                                                       1B2
      Y2STL(I)=0.                                                       1B2
      I=I-1                                                             1B2
      IF (NSTL-I) 12,13,13                                              1B2
13    DO 14 J=1,NSTL                                                    1B2
14    READ (2,98) AS(J),X1STL(J),Y1STL(J),BARN(J),X2STL(J),Y2STL(J)     1B2
15    READ (2,101) CODE,P,XM,YM,RATIO,B,ACCR                            1B2
      ITCNT=0                                                           1B2
      KSWC=1                                                            1B2
      KSWD=1                                                            1B2
      KSWE=1                                                            1B2
      KSWH=1                                                            1B2
      KSW6=1                                                            1B2
      ONEN=B*RATIO-1.                                                   1B2
      PRMN=ONEN                                                         1B2
      IF (ISWT1) 16,17,16                                               1B2
16    READ (2,116) IDENT,S,T,U                                          1B2
      WRITE (3,117) IDENT                                               1B2
      WRITE (3,109) S,T,U                                               1B2
      GO TO 78                                                          1B2
17    KSWFZ=1                                                           1B2
      KSWG=1                                                            1B2
      ITCNT=ITCNT+1                                                     1B2
      IF (ITCNT-ICLMT) 19,19,18                                         1B2
```

```
18      WRITE (3,114)                                                                1B2
        WRITE (3,104)                                                                1B2
        WRITE (3,105)                                                                1B2
        WRITE (3,106) CODE                                                           1B2
        WRITE (3,107)                                                                1B2
        WRITE (3,108) P,XM,YM,RATIO,B,ACCR                                           1B2
        WRITE (3,104)                                                                1B2
        GO TO 93                                                                     1B2
19      A=0.                                                                         1B2
        ABARX=0.                                                                     1B2
        ABARY=0.                                                                     1B2
        XIN=0.                                                                       1B2
        YIN=0.                                                                       1B2
        XYIN=0.                                                                      1B2
        I=1                                                                          1B2
        XI=XCON(I)                                                                   1B2
        YI=YCON(I)                                                                   1B2
        GO TO (20,25), KSWC                                                          1B2
20      DO 24 I=2,NCON                                                               1B2
        XI=XCON(I)                                                                   1B2
        XIM1=XCON(I-1)                                                               1B2
        YI=YCON(I)                                                                   1B2
        YIM1=YCON(I-1)                                                               1B2
        GO TO (21,25), KSWC                                                          1B2
21      DELX=XI-XIM1                                                                 1B2
        V1=YI+YIM1                                                                   1B2
        V2=XI+XIM1                                                                   1B2
        V3=XI*YI                                                                     1B2
        V4=XIM1*YIM1                                                                 1B2
        V5=V1*V1                                                                     1B2
        A=A+(DELX/2)*V1                                                              1B2
        ABARX=ABARX+(DELX/6.)*(V1*V2+V3+V4)                                          1B2
        ABARY=ABARY+(DELX/6.)*(V5-YI*YIM1)                                           1B2
        XIN=XIN+(DELX/12.)*(V2*V2*V1+2.*(V3*XI+V4*XIM1))                             1B2
        YIN=YIN+(DELX/12.)*(V5*V1-2.*YI*YIM1*V1)                                     1B2
        XYIN=XYIN+(DELX/24.)*(XI*(V5+2.*YI*YI)+XIM1*(V5+2.*YIM1*YIM1))               1B2
        IF (ISWT2) 22,23,22                                                          1B2
22      WRITE (3,99) ITCNT,ICON1                                                     1B2
        WRITE (3,100) A,ABARX,ABARY,XIN,YIN,XYIN                                     1B2
        WRITE (3,100) XI,YI,XIM1,YIM1                                                1B2
23      GO TO (24,49,49,48), KSWH                                                    1B2
24      CONTINUE                                                                     1B2
        GO TO 52                                                                     1B2
25      FI=U+S*XI+T*YI                                                               1B2
        GO TO (26,32,30), KSW3                                                       1B2
26      DEL=FI-FZ(I)                                                                 1B2
27      DELL=DEL                                                                     1B2
        IF (DEL) 28,29,29                                                            1B2
28      DELL=-DELL                                                                   1B2
29      IF (DELL-ACCR) 32,32,31                                                      1B2
30      DEL=FI                                                                       1B2
        GO TO 27                                                                     1B2
31      KSWD=1                                                                       1B2
        KSW3=2                                                                       1B2
32      FZ(I)=FI                                                                     1B2
        IF (FI) 33,35,35                                                             1B2
33      GO TO (34,24,39), KSWFZ                                                      1B2
34      KSWFZ=2                                                                      1B2
        GO TO 20                                                                     1B2
35      GO TO (36,37,21), KSWFZ                                                      1B2
36      KSWFZ=3                                                                      1B2
        GO TO 20                                                                     1B2
```

```
37    KSWFZ=3                                                          1B2
      KSW4=2                                                           1B2
38    DELX=XI-XIM1                                                     1B2
      DELY=YI-YIM1                                                     1B2
      FIOD=FI/(FI-FZ(I-1))                                             1B2
      XINT=XI-DELX*FIOD                                                1B2
      YINT=YI-DELY*FIOD                                                1B2
      GO TO (40,46), KSW4                                              1B2
39    KSWFZ=2                                                          1B2
      KSW4=1                                                           1B2
      GO TO 38                                                         1B2
40    GO TO (41,45), KSWG                                              1B2
41    KSWG=2                                                           1B2
      XINTL=XINT                                                       1B2
      YINTL=YINT                                                       1B2
      GO TO (96,42,44), KSWFZ                                          1B2
42    KSWH=3                                                           1B2
43    XI=XINT                                                          1B2
      YI=YINT                                                          1B2
      GO TO 21                                                         1B2
44    XIM1=XINT                                                        1B2
      YIM1=YINT                                                        1B2
      GO TO 21                                                         1B2
45    KSWG=1                                                           1B2
      KSWH=4                                                           1B2
      GO TO 43                                                         1B2
46    GO TO (41,47), KSWG                                              1B2
47    KSWG=1                                                           1B2
      KSWH=2                                                           1B2
      XIM1=XINTL                                                       1B2
      YIM1=YINTL                                                       1B2
      GO TO 43                                                         1B2
48    KSWH=3                                                           1B2
      XI=XINTL                                                         1B2
      YI=YINTL                                                         1B2
      GO TO 44                                                         1B2
49    XI=XCON(I)                                                       1B2
      YI=YCON(I)                                                       1B2
      GO TO (96,50,51,96), KSWH                                        1B2
50    KSWH=1                                                           1B2
      GO TO 44                                                         1B2
51    KSWH=1                                                           1B2
      GO TO 24                                                         1B2
52    GO TO (53,61), KSWD                                              1B2
53    IF (NSTL) 96,75,54                                               1B2
54    DO 61 J=1,NSTL                                                   1B2
      ASJ=AS(J)                                                        1B2
      X1=X1STL(J)                                                      1B2
      Y1=Y1STL(J)                                                      1B2
      BARNO=BARN(J)                                                    1B2
      X2=X2STL(J)                                                      1B2
      Y2=Y2STL(J)                                                      1B2
      KSW8=1                                                           1B2
      GO TO (55,66), KSWC                                              1B2
55    AFN=PRMN*ASJ*BARNO                                               1B2
      IF (BARNO-1.0) 96,56,57                                          1B2
56    FRAC=0.                                                          1B2
      X2=X1                                                            1B2
      Y2=Y1                                                            1B2
      GO TO 58                                                         1B2
57    FRAC=(2.0*BARNO-1.0)/(6.0*(BARNO-1.0))                           1B2
58    A=A+AFN                                                          1B2
```

```
        ABARX=ABARX+(AEN*(X1+X2)/2.0)                                       1B2
        XIN=XIN+AEN*(X1*X2+FRAC*(X2-X1)**2)                                 1B2
        YIN=YIN+AEN*(Y1*Y2+FRAC*(Y2-Y1)**2)                                 1B2
        ABARY=ABARY+AEN*(Y1+Y2)/2.0                                         1B2
        XYIN=XYIN+AEN*(((X1*Y2+X2*Y1)/2.0)+FRAC*(X2-X1)*(Y2-Y1))            1B2
        IF (ISWT2) 59,60,59                                                 1B2
59      WRITE (3,99) ITCNT,ICON2                                            1B2
        WRITE (3,100) A,ABARX,ABARY,XIN,YIN,XYIN                            1B2
        WRITE (3,100) X1,Y1,X2,Y2                                           1B2
60      GO TO (61,62), KSW8                                                 1B2
61      CONTINUE                                                            1B2
        GO TO 75                                                            1B2
62      BARNO=PRN                                                           1B2
        F1=F1                                                               1B2
        X1=X2+DX                                                            1B2
        Y1=Y2+DY                                                            1B2
        X2=X2STL(J)                                                         1B2
        Y2=Y2STL(J)                                                         1B2
        KSW8=1                                                              1B2
63      IF (F1) 64,64,65                                                    1B2
64      PRMN=RATIO                                                          1B2
        GO TO 55                                                            1B2
65      PRMN=ONEN                                                           1B2
        GO TO 55                                                            1B2
66      F1=U+S*X1+T*Y1                                                      1B2
        IF (BARNO-1.0) 96,63,67                                             1B2
67      F2=U+S*X2+T*Y2                                                      1B2
        IF (F1) 69,68,68                                                    1B2
68      IF (F2) 70,65,65                                                    1B2
69      IF (F2) 64,70,70                                                    1B2
70      DX=(X2-X1)/(BARNO-1.0)                                              1B2
        DY=(Y2-Y1)/(BARNO-1.0)                                              1B2
        COUNT=0.0                                                           1B2
        GO TO 72                                                            1B2
71      X1=X1+DX                                                            1B2
        Y1=Y1+DY                                                            1B2
72      F1=U+S*X1+T*Y1                                                      1B2
        IF (F1*F1) 74,74,73                                                 1B2
73      COUNT=COUNT+1.0                                                     1B2
        IF (COUNT-BARNO) 71,63,96                                           1B2
74      PRN=BARNO-COUNT                                                     1B2
        BARNO=COUNT                                                         1B2
        X2=X1-DX                                                            1B2
        Y2=Y1-DY                                                            1B2
        X1=X1STL(J)                                                         1B2
        Y1=Y1STL(J)                                                         1B2
        KSW8=2                                                              1B2
        GO TO 63                                                            1B2
75      BARX=ABARX/A                                                        1B2
        BARY=ABARY/A                                                        1B2
        XOI=XIN-ABARX*BARX                                                  1B2
        YOI=YIN-ABARY*BARY                                                  1B2
        XYOI=XYIN-ABARX*BARY                                                1B2
        XOM=XM-P*BARX                                                       1B2
        YOM=YM-P*BARY                                                       1B2
        CN=XOM-YOM*XYOI/YOI                                                 1B2
        CD=XOI-XYOI*XYOI/YOI                                                1B2
        DN=YOM-XOM*XYOI/XOI                                                 1B2
        DD=YOI-XYOI*XYOI/XOI                                                1B2
        S=CN/CD                                                             1B2
        T=DN/DD                                                             1B2
        U=(P-S*ABARX-T*ABARY)/A                                             1B2
```

```
      IF (ISWT2) 76,77,76                                               1B2
76    WRITE (3,99) ITCNT,ICON3                                          1B2
      WRITE (3,100) X01,Y01,XY01,XOM,YOM                                1B2
      WRITE (3,100) CN,CD,ON,DO                                         1B2
      WRITE (3,100) S,T,U                                               1B2
77    GO TO (78,80), KSWE                                               1B2
78    KSWC=2                                                            1B2
      KSWE=2                                                            1B2
      KSW3=3                                                            1B2
79    KSWD=2                                                            1B2
      GO TO 17                                                          1B2
80    KSW3=1                                                            1B2
      GO TO 79                                                          1B2
81    WRITE (3,113) TITLE                                               1B2
      WRITE (3,106) CODE                                                1B2
      WRITE (3,107)                                                     1B2
      WRITE (3,108) P,XM,YM,RATIO,B,ACCR                                1B2
      WRITE (3,99) ITCNT                                                1B2
      WRITE (3,109) S,T,U                                               1B2
      WRITE (3,110)                                                     1B2
      DO 82 I=1,NCON,1                                                  1B2
82    WRITE (3,111) FZ(I),XCON(I),YCON(I)                               1B2
      IF (NSTL) 96,93,83                                                1B2
83    WRITE (3,102)                                                     1B2
      DO 92 J=1,NSTL                                                    1B2
      F1=U+S*X1STL(J)+T*Y1STL(J)                                        1B2
      IF (F1) 84,86,85                                                  1B2
84    F1=F1*RATIO                                                       1B2
      GO TO 86                                                          1B2
85    F1=F1*RATIO*B                                                     1B2
86    IF (BARN(J)-1.0) 96,91,87                                         1B2
87    F2=U+S*X2STL(J)+T*Y2STL(J)                                        1B2
      IF (F2) 88,90,89                                                  1B2
88    F2=F2*RATIO                                                       1B2
      GO TO 90                                                          1B2
89    F2=F2*RATIO*B                                                     1B2
90    GO TO 92                                                          1B2
91    F2=0.0                                                            1B2
      X2STL(J)=0.0                                                      1B2
      Y2STL(J)=0.0                                                      1B2
92    WRITE (3,112) X1STL(J),Y1STL(J),F1,X2STL(J),Y2STL(J),F2,AS(J)     1B2
93    IF (NLD-KLD) 94,94,95                                             1B2
94    KLD=1                                                             1B2
      NCON1=NCON                                                        1B2
      NSTL1=NSTL                                                        1B2
      GO TO 1                                                           1B2
95    KLD=KLD+1                                                         1B2
      GO TO 15                                                          1B2
96    CALL EXIT                                                         1B2
C                                                                       1B2
97    FORMAT (6I10)                                                     1B2
98    FORMAT (6F10.3)                                                   1B2
99    FORMAT ('0',T25,'ITERATIONCOUNT=',I3,I5)                          1B2
100   FORMAT (T25,6F10.2)                                               1B2
101   FORMAT (5A4,6F10.0)                                               1B2
102   FORMAT ('0',T25,'STEELSTRESSES'/T31,'X1',T41,'Y1',T49,'STRESS',T611B2
     1,'X2',T71,'Y2',T79,'STRESS',T89,'BARAREA')                        1B2
103   FORMAT (20A4)                                                     1B2
104   FORMAT ('0////////////////////////////////////////////////////////1B2
     1//////////////////////////////////////////////////////////////////1B2
     2//////////')                                                      1B2
105   FORMAT ('0',T25,'EXCESSIVEITERATIONS-CHECKDATA/CONSULTPROGRAMWRITE1B2
```

```
      1-UP')                                                            1B2
106    FORMAT (T25,'LOADINGIDENTIFICATION=',5A4,T1'0')                  1B2
107    FORMAT ('0',T25,'AXIALLOAD',T43,'MX',T53,'MY',T62,'N',T73,'R',T81,1B2
      1'ACCURACY')                                                      1B2
108    FORMAT (T25,F10.2,T37,F10.1,T47,F10.1,T57,F10.3,T67,F10.3,T77,F10.1B2
      13)                                                               1B2
109    FORMAT (T25,'GENERALFLEXUREFORMULA---STRESS=',F10.5,'X+',F10.5,'Y+1B2
      1',F10.5,T1'0')                                                   1B2
110    FORMAT ('0',T25,'CONCRETESTRESSATCOORDINATES'/T48,'X',T58,'Y')   1B2
111    FORMAT (T27,F10.3,T42,F10.3,T52,F10.3)                           1B2
112    FORMAT (T25,/F10.3)                                              1B2
113    FORMAT (1H1,T25,20A4)                                            1B2
114    FORMAT ('1')                                                     1B2
115    FORMAT ('0',T25,'CONCRETECOORDINATESDONOTCLOSE-JOBTERMINATED')   1B2
116    FORMAT (I10,3F10.3)                                              1B2
117    FORMAT (T45,'FIRSTGUESSNO.',I10,T1,'0')                          1B2
       END                                                              1B2
// DUP
*STORE        WS   UA   M1B2
// XEQ M1B2
```

```
   HOLLOW REINFORCED CONCRETE SHAFT FOR 1B2
LOADINGIDENTIFICATION=  LL + DL + WIND

AXIALLOAD         MX         MY         N          R          ACCURACY
    10.00         60.0       10.0     10.000     2.000        .010

ITERATIONCOUNT=  5
GENERALFLEXUREFORMULA---STRESS=   -.13771X+   -.23104Y+   1.84827

CONCRETESTRESSATCOORDINATES
                            X          Y
      1.022               6.000       .000
       .142               4.000      5.000
     -1.008               9.000      7.000
      -.129              11.000      2.000
       .053               8.000      3.000
      -.178               8.000      4.000
      -.040               7.000      4.000
       .191               7.000      3.000
       .053               8.000      3.000
      -.129              11.000      2.000
      1.022               6.000       .000

STEELSTRESSES
     X1          Y1         STRESS        X2          Y2        STRESS      BARAREA
    7.000       2.000        8.444        .000        .000        .000       1.000
    6.000       4.000        1.957        .000        .000        .000       1.000
    8.000       5.000       -4.086       9.000       3.000       -.842       1.000
```

```
   HOLLOW REINFORCED CONCRETE SHAFT FOR 1B2
LOADINGIDENTIFICATION=  LL + DL

AXIALLOAD          MX          MY        N           R          ACCURACY
    10.00          80.0        50.0     10.000       2.000         .010

ITERATIONCOUNT=  4
GENERALFLEXUREFORMULA---STRESS=     .04016X+     .11907Y+    -.64652

CONCRETESTRESSATCOORDINATES
                            X          Y
      -.406               6.000       .000
       .109               4.000      5.000
       .548               9.000      7.000
       .033              11.000      2.000
       .032               8.000      3.000
       .151               8.000      4.000
       .111               7.000      4.000
      -.008               7.000      3.000
       .032               8.000      3.000
       .033              11.000      2.000
      -.405               6.000       .000

STEELSTRESSES
    X1           Y1         STRESS        X2          Y2          STRESS        BARAREA
   7.000        2.000       -1.273        .000        .000          .000         1.000
   6.000        4.000        1.415        .000        .000          .000         1.000
   8.000        5.000        5.402       9.000       3.000         1.443         1.000
```

LISTING AND SAMPLE OUTPUT FOR 1.B.3
"Tied Concrete Columns, Planar Bending"

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
C     UNSYMMETRICAL TIED COLUMN ANALYSIS                                1B3
      READ (2,2) FY,FCP,C,EN,B,T,D,G                                    1B3
1     READ (2,3) AS,ASP                                                 1B3
      WRITE (3,4)                                                       1B3
      WRITE (3,5)                                                       1B3
      WRITE (3,6)                                                       1B3
      WRITE (3,7) FY,FCP,C,EN,B,T,D,G,AS,ASP                            1B3
      R=AS/ASP                                                          1B3
      PG=(AS+ASP)/(B*T)                                                 1B3
      DDT=D/T                                                           1B3
      EM=FY/(.85*FCP)                                                   1B3
      AG=B*T                                                            1B3
      AGFCP=(AG*FCP)/1000.                                              1B3
      AFT=(AGFCP*T)/12.                                                 1B3
      WRITE (3,8)                                                       1B3
      WRITE (3,9) PG,R,DDT                                              1B3
      ALPHA=((((PG*EM)*G)*(1./(1.+R)))+(.1*(DDT**2)))/(((PG*EM)*((1.-R)/1B3
     1(1.+R)))+(0.6*(DDT)))                                             1B3
      BETA=(.5+((((2.*EN)-1.)/(1.+R))*PG)*(((R+1.)*DDT)-G))/(1.+(((2.*EN1B3
     1)-1.)*PG))                                                        1B3
      PHI=(.0833+((((2.*EN)-1.)/(1.+R))*PG)*((R*((DDT-.5)**2))+(((.5-DD1B3
     1T)+G)**2))))-((1.+(((2.*EN)-1.)*PG))*((BETA-.5)**2))              1B3
      GAMM =    (((2.*PG)/(1.+R))*((R*EN*DDT)+(((2.*EN)-1.)*(DDT-G)))+((1B3
     1(PG/(1.+R))*(((2.*EN)-1.)+(R*EN)))**2))
      GAM =SQRT(GAMM)
      GAMMA=GAM     -((PG/(1.+R))*(((2.*EN)-1.)+R*EN))                  1B3
      UPS=(((GAMMA**2)/6.)+((((2.*EN)-1.)/(1.+R))*(PG/GAMMA)*((GAMMA-DDT1B3
     1)+G)*(DDT-G)))/((GAMMA/2.)+((((2.*EN)-1.)/(1.+R))*(PG/GAMMA)*((GAM1B3
     2MA-DDT)+G)))                                                      1B3
      PODAF=.34*(1.+(PG*EM))                                            1B3
      PO=PODAF*AGFCP                                                    1B3
      PADAF=.2125+((.209*PG)*EM)                                        1B3
      PA=PADAF*AGFCP                                                    1B3
      XNBAF=((PODAF*PHI)*C)/((PHI*C)+((PODAF*ALPHA)*BETA))              1B3
      XNB=XNBAF*AGFCP                                                   1B3
      XMBAF=ALPHA*XNBAF                                                 1B3
      XMB=XMBAF*AFT                                                     1B3
      XMOAF=(((.34*PG)*EM)*(R/(1.+R)))*(DDT-UPS)                        1B3
      XMO=XMOAF*AFT                                                     1B3
      WRITE (3,10)                                                      1B3
      WRITE (3,11) PODAF,PADAF,XNBAF,XMBAF,XMOAF                        1B3
      WRITE (3,5)                                                       1B3
      WRITE(3,13)
      WRITE (3,12) PO,PA,XNB,XMB,XMO                                    1B3
      GO TO 1                                                           1B3
C                                                                       1B3
2     FORMAT (2F6.0,F5.3,4F5.2,F5.3)                                    1B3
3     FORMAT (2F5.0)                                                    1B3
4     FORMAT ('1',T41,'1963ACIUNSYMMETRICALTIEDCOLUMNANALYSIS(WSD)')    1B3
5     FORMAT ('0')                                                      1B3
6     FORMAT ('0',T30,'FY',T39,'FC''',T47,'C',T53,'N',T61,'B',T69,'T',T71B3
     17,'D',T84,'G',T92,'AS',T100,'AS''')                               1B3
7     FORMAT (T25,F9.0,F8.0,F7.3,F7.2,3F8.2,F7.3,2F8.2)                 1B3
8     FORMAT ('0',T58,'PG          R         D/T')                      1B3
9     FORMAT (T52,F9.4,F9.3,F8.4)                                       1B3
10    FORMAT ('0',T35,'PO/AGFC''',T45,'PA/AGFC''',T60,'NB/AGFC''',T75,'M1B3
     1B/AGFC''T',T85,'MO/AGFC''T')                                      1B3
11    FORMAT (T34,F7.4,2(6X,F7.4),2(7X,F7.4))                           1B3
12    FORMAT(' ',T32,F9.0,2(4X,F9.0),5X,F10.1,4X,F10.1)                 1B3
```

```
 13 FORMAT(T37,'PD',T50,'PA',T65,'NB',T79,'MB',T93,'MO')
    END
/ DUP
STORE      WS  UA  MIB3
// XEQ MIB3
```

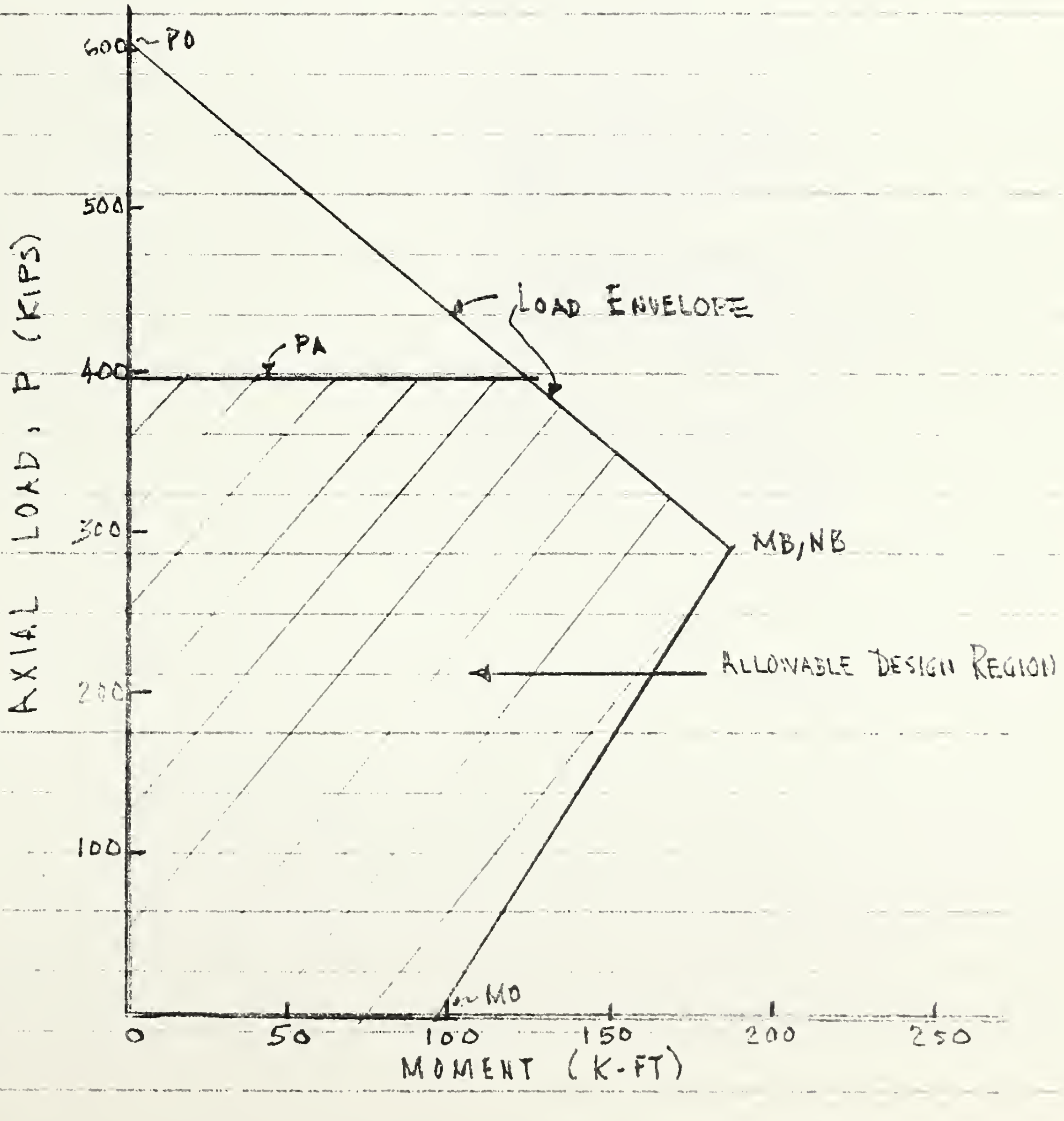
```
           1963ACIUNSYMMETRICALTIEDCOLUMNANALYSIS(WSD)

  FY        FC'       C        N         B         T         D        G         AS        AS'
0000.     3000.     .450     9.20     18.00     28.00     25.50     .822      3.16      2.40

                                     PG        R        D/T
                                   .0110     1.317     .9107

      PO/AGFC'      PA/AGFC'      NB/AGFC'        MB/AGFC'T       MO/AGFC'T
       .3988         .2625         .1920           .0530            .0277


        PO            PA            NB              MB               MO
        603.          397.          290.            187.0            97.9
```



ACKNOWLEDGEMENT

Program No.	Originator
1.A.1	E. M. Alter U. S. Corps of Engineers Buffalo, N. Y.
1.A.2	E. C. Demsky U. S. Army Engineer District St. Louis, Mo.
1.B.1	M. H. Harter, et al Dept. of the Army Corps of Engineers Kansas City, Mo.
1.B.2	H. Miller, et al Corp of Engineers 1519 Alaskan Way South Seattle, Washington
1.B.3	R. D. Hudson, et al Corps of Engineers 1519 Alaskan Way South Seattle, Washington

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